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TROPICAL AGRICULTURIST

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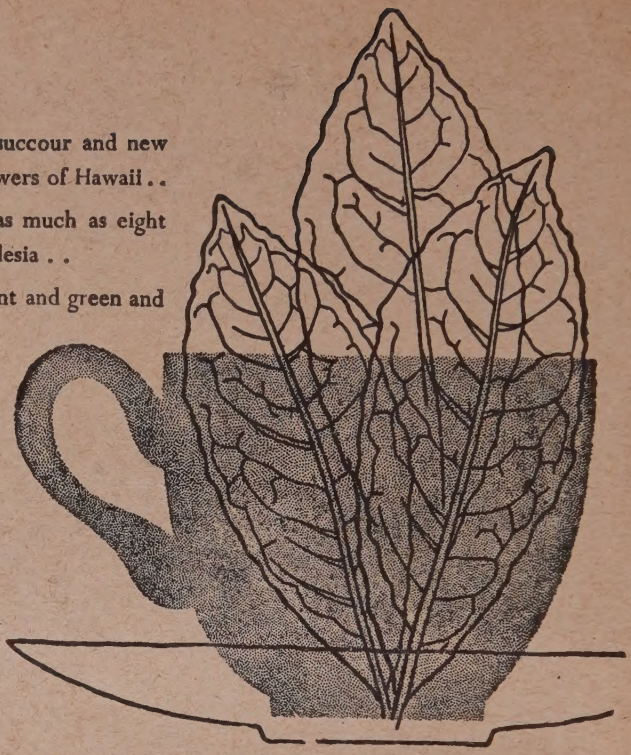

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TROPICAL AGRICULTURIST

AGRICULTURAL JOURNAL OF CEYLON

VOLUME CXIV, NUMBER 2, 1958

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DR. M. F. CHANDRARATNA
Director of Agriculture

CEYLON DEPARTMENT OF AGRICULTURE

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EDITORIAL

Prospects for Potatoes

As the Andean centre of origin of the potato is confined completely to a low latitude, it is a matter of considerable surprise that for many years, in tropical countries, there has been no active search for areas with a comparable climate in which successful potato growing would have been possible. Misplaced emphasis on the role of photoperiod factors in tuberisation contributed to this initial lack of enthusiasm. In recent years, a critical assessment of environmental factors influencing potato production has demonstrated the overwhelming importance of the temperature relations of the crop. The temperatures at which optimum growth and tuber formation occur vary within exceptionally narrow limits. Frost devastates the crop, and temperatures above 70°F depress tuber formation. A potato climate must accordingly be cold but completely frostfree. As has been suggested by Dr. Pushkarnath, Director of the Central Potato Research Institute, Simla, who visited Ceylon in 1958 under the Colombo Plan, in the valuable report reproduced herein, extensive areas in which temperature fluctuations do not transgress the stipulated limits in both the North East and South West monsoon seasons exist at the high altitudes in this country. Nuwara Eliya (elevation: 6200 ft.) has a temperature mean of 60°F, a value that is optimal for tuberisation. Even the Diyatalawa area (elevation 4100 ft.) is below the 70°F isotherm, and can accordingly produce very high tuber yields: in trials at Rahangala, an area with a comparable elevation and climate, the Department's Botanist records yields of over 12 tons per acre with the varieties *Up-to-date, Great Scot* and *Alpha.*

Ceylon's annual potato imports approximate 38,000 tons and cost nearly 14 million rupees. At an average acre yield of 4-5 tons, an annual acreage of about 8000 is all that is needed for self-sufficiency. There is little doubt that the land that stretches between Nuwara Eliya and Diyatalawa can provide this acreage.

Apart from its fastidious temperature demands, the potato succumbs to a diversity of diseases. The extensive promotion of potato growing in this country will be possible only if the local production of disease-free seed succeeds. A seed production and certification

scheme in which the cumulative degeneration of seed stocks by aphid-borne viruses is, if not eliminated, at least minimized, has been conceived by Dr. Pushkarnath, and is being implemented by the Department of Agriculture. His modest report does not convey adequately the magnitude of his contribution to Ceylon's nascent potato industry.

Bacterial wilt is completely unknown in the temperate latitudes. In Ceylon, on the other hand, this disease constitutes the most serious hazard in potato growing, and any scheme of potato extension in this country must be designed to contain bacterial wilt within its present limits. It is heartening to note that in the recent surveys conducted by Dr. D. V. Abeygunawardena, Research Co-ordinator, Rahangala, the wilt bacterium has not been recorded at elevations above 6,000 ft. and the strictest measures must be used to prevent the movement to this wilt-free zone, of seed potatoes and other infective material from lower altitudes.

Inexpert handling of disease problems was the main cause of the pathetic failure of the earlier potato project. When the Department resuscitated potato research in 1957, disease control received particular emphasis. The papers presented in this number constitute a fine record of integrated research in the fields of pathology and agronomy. At a time when potato growing is expanding at an explosive rate, the need for rigid precautions in the planning and execution of extension programmes cannot be too strongly stressed.

Report of Dr. Pushkarnath, M. Sc. Ph. D., Assoc. I. A. R. I., Director, Central Potato Research Institute, Simla, on his visit to Ceylon in connection with assessing the possibilities and prospects of potato culture*

I ARRIVED in Colombo on the 18th of March and left the country on the 3rd April. During my short stay in Ceylon, I had the opportunity to visit the potential potato-growing areas, and discuss on several occasions, the possibilities of potato growing with the Director of Agriculture and his technical staff. As a result of these discussions and meetings, a plan of future work was framed by the Director of Agriculture. I had also the privilege of meeting and discussing the potentialities of potato growing with the Hon'ble Philip Gunawardena, Minister of Agriculture and Food. The itinerary in respect of my visit is enclosed.

Geographical Features

Ceylon, with an area of 25,333 square miles, consists of a hilly area (located in the south-central part with a height ranging up to 8,000 ft. above sea level) and the plains. The high ranges are surrounded by a low hill belt which gradually slopes into the coastal plains. The hill areas above 4,000 feet constitute the tract which may be said to be climatically suitable for potato cultivation.

On account of its proximity to the equator, within the latitude of 6 to 10 degrees north (the mean temperature ranging from 80°F to 82 F.) Ceylon cannot be considered favourite for potato growing in the low country areas. However, in the hill country temperatures drop steadily (roughly about 1° for every 300 feet of rise in elevation). The temperatures in the hill regions are, therefore, much more mild than in the plains. Thus, the average temperature in Peradeniya (1,600 feet above sea level) is 77°F ; at Diyatalawa near Rahangala Farm (elevation 4,100 ft.) the temperature is 68°F, and at Nuwara Eliya, the chief hill station of the country

* Under Technical Co-operation in South Asia (Colombo Plan).

(about 6,200 feet above sea level) the mean temperature is 60°F. One of the very important features is very little seasonal variability and less marked difference between maximum and the minimum temperatures. No rigid seasons for planting and harvesting can, therefore, be defined. The time of planting and harvesting would appear to be mainly dependent on the rainfall conditions and frost (in high hill elevations only). Broadly speaking there are two main rainy seasons : the south-west monsoon between April and June and the north-east monsoon between October and December. There is great variability, particularly in the hill regions, in rainfall. The time and intensity of rainfall appear to be dependent on the aspect in which the hill slopes are situated. In between the monsoon seasons occasional showers are not uncommon. In the cooler regions up in the hills, these occasional showers are more frequent making it possible, it would appear to me, to grow potato without irrigation at least in some locations.

Prospects of Potato Crop Cultivation

Potato growing is a new venture in Ceylon. There are extensive Government-owned *patana* lands in higher elevations which if they could be brought under potato cultivation will greatly help to provide additional food resources within the country. In the past some attempts to cultivate potatoes had been made, but the experiments had not been very encouraging. These failures were perhaps the result of lack of experience in potato cultivation. The potato campaign was revived recently, and in the year 1956-57 very encouraging results have been obtained. Some of the varieties like *Up-to-date, Alpha* and *Great Scot* yielded well over 12 tons to an acre (*Up-to-date* yielding 14 tons and more). These yield figures (if they are correctly reported) are by themselves an index to the potentialities which the country offers for the successful cultivation of potatoes. The average yields of potatoes in various countries as reported in the F.A.O. Hand Book of Agricultural Statistics, 1946, are as follows :—

Name of country	*Yield in tons*
Australia	3.0
Belgium	8.2
Canada	3.3
Czechoslovakia	5.3
Eire	8.0
France	4.4
Germany	6.9
Italy	2.6
Japan	5.4

Name of country	*Yield in tons*
Netherlands	8.4
Sweden	5.5
United States of America	3.1
United States of Soviet Russia	3.3
India	3.6*

Compared to international standards, it would be seen, the yields obtained in Ceylon are very good. It is, however, unlikely that average yields of 12 tons can be secured in cultivators' holdings. Nevertheless, potato culture in the hills of Ceylon would appear to be full of promise. In spite of these promising yield figures, potato cultivation in Ceylon presents some serious problems mainly connected with diseases. These are referred to later in this report.

There is at present great lack of information and data which would have been of help to me in formulating firm plans for potato production in the country. This data will have to be secured with a view to place the potato industry in the country on a sound scientific footing. As to the programme that may be followed in this connection I have indicated it under appropriate heads in this report. I also discussed, on a number of occasions the details in this regard with the Director and his technical staff.

Present Work

At present the potato work is being carried out at Rahangala and Bopatalawa Farms by the Department of Agriculture. No serious attempts have so far been made to extend potato cultivation into the cultivators' holdings. In this direction a phased programme could, with advantage, be instituted and simultaneously information of value for extension of potato cultivation on a large scale secured. In connection with the extension programme, some caution is necessary so as to avoid possible failures of crop and thereby shaking the confidence of growers. I shall briefly allude to this in the connected paragraphs of this report.

Problems of Potato Growing

The main problems of potato growing may be classified in three heads :

(i) **Availability of Seed.** At present all the seed potatoes required by the country are imported from different countries mainly the

(*Based on marketing report on potatoes in India.)

Netherlands and the United Kingdom. This dependence on foreign imports allows the Ceylon Government to import seed stocks only during such periods when stocks (in a condition fit for planting) are available for export in the countries of their origin. At present, therefore, naturally the time of sowing of potato depends upon the time when such imports are available. This to my mind is not a very satisfactory position, particularly when advantage could be taken to raise a number of crops (depending on elevation and climatic conditions) within a year. The climate of Ceylon in the hilly regions is suitable for growing potatoes for a large part of the year, and in fact two or even sometimes three crops can be grown within a year by adjusting the dates of sowing and the dates of harvesting. It is necessary for the Government, I feel, to organize internal sources of seed so that availability of seed potatoes could be assured at all times and during periods which are considered suitable for planting in different areas.

(ii) Later when the information regarding the dates of sowing in different areas is more definitely known and if the pilot project at Horton Plains succeeds, as it should, it may be desirable to preserve seed potatoes under cold storage conditions so that a regular source of seed for different planting times (which I visualize to be quite a few, depending on elevation and rainfall) could be assured.

(iii) Simultaneously, with such a pilot undertaking it would be necessary to ensure that the areas selected for production of seed are :—

(*a*) **Free from bacterial wilt infection :** By growing the crops on an experimental scale it should be ensured that the area selected is free from wilt diseases. In such wilt-free areas **no seed potatoes which are not certified to be free from infection should be grown.** In this connection, I may indicate that Ceylon imports large quantities of potatoes (mainly for table purposes) from Mediterranean countries like Cyprus, Malta and British possessions in Africa, Tanganyika and the Union of South Africa. There is no guarantee that potatoes imported into Ceylon from these countries are free from bacterial wilt organisms. These stocks are sometimes used as seed and I have observed that even in the high hilly areas like Horton Plains such infected stocks find their way as seed. Effective steps will have to be taken to ensure that in the higher hilly regions, marked for seed production, no potatoes which the department does not certify to be free from diseases (viruses and bacterial wilt in particular) are grown.

(b) **Reasonably free from aphid infestation**: Much of the success of these seed areas would depend as to how effectively stocks can be kept free from degenerating effects caused by virus diseases. This could be assessed by :

(i) Taking periodic counts of aphids known to be responsible for carrying virus infection under local conditions.

(ii) By securing information on the percentage of virus infection (particularly virus Y and leaf roll) on the crops grown in the area selected.

Here I may mention that :—

(1) It is presumed that in areas selected for seed production only certified disease-free stocks are planted.

(2) In the areas selected for seed production I do not visualize that stocks can be maintained in a disease-free condition indefinitely but even if once, twice or thrice grown locally produced stocks are found useful as seed it will considerably reduce dependence on foreign imports.

(iv) As the work on seed production develops it may be necessary to locate other areas in the high hilly regions where seed potato production can be carried out with profit. To locate such areas it would be desirable to carry out some preliminary work with a view to secure information on freedom from bacterial wilt of the sites selected and incidence of aphid and virus diseases. I discussed the plans and programme for securing this information in detail with the technical officers at meetings arranged by the Director of Agriculture at Peradeniya on the 25th March and again in 31st March.

2. **The Problem of Disease**: The problem of disease control presents very grave and specific problems. The diseases which are of importance are :

(i) **Bacterial Wilt**: At present very little is known as to the organisms which are responsible for causing the wilts. It is desirable to secure this information. There is, however, no doubt that brown rot is widely prevalent. Brown rot is a bacterial disease caused by *Pseudomonas solanacearum*. It can be carried easily through infected seed tubers. When the soils are infected it is very difficult to control the disease and the infection builds up in soil. This organism attacks not only potato but several other *solanaceous* members and plants belonging to several other families.

Immediate precautions in this connection appear to be :

(*a*) To maintain the areas selected for seed potato production completely under strict quarantine conditions.

(*b*) Not to use potatoes grown in the lower areas as seed in the higher areas. It would appear from information that I was able to gather, that the disease is more serious in the lower elevation than in the higher elevations.

(*c*) Carry out a survey of the potential important potato growing areas with a view to locate situations which are free from wilt organisms and thus suitable for potato growing.

(*d*) Practice long rotations.

(ii) **Late Blight :** I am told that Late Blight is a severe disease. I have not examined nor seen any specimens myself as at the time of my visit there was no Late Blight in the fields. As a precaution against the disease frequent spraying with copper fungicides is practised by the department. Here again there is lack of data with regard to the conditions which favour the appearance and spread of the disease and the periods when the disease is likely to appear. It would be desirable to secure this information. If this information is secured, spraying programme can be rationalized and much expenditure, labour at present spent for too frequent spraying operations avoided.

As a result of discussion with the various officers I understood that Late Blight appears and builds up into an epidemic during the rainy periods. It is very probable that losses due to this disease could be minimised if the sowing dates are so adjusted that the crops are allowed to mature before the rains set in. It would also be necessary to develop a schedule of spraying operations to be carried out by the cultivators. These schedules should be drawn in relation to time of appearance of disease under different conditions of potato culture in the country.

Introduction of resistant varieties (like Tedria which is said to give good yields under local conditions) would be desirable particularly in areas where Late Blight is a severe menace.

With necessary adjustments in sowing time, right choice of varieties and an effective spraying programme I feel that the problem of Late Blight should not be so serious as it now appears to be. The disease could be controlled within manageable limits.

(iii) **Eelworms :** As a result of my visit to the Tea Research Institute, Talawakelle, I discovered that the eelworm affecting tea is the same species as that which causes tuber and root gall formation in the

potato. I examined some samples at the Tea Research Institute and the species involved is *Meloidogyne javanica*. Local sources did not indicate that eelworm presented a problem in potato culture. I would like to caution that eelworm is a very troublesome pest and once it gets into the soil it rapidly builds up and may, in course of time, present serious problems in the way of successful potato cultivation. It would, therefore, be desirable to keep strict watch over this pest. Here I may mention that I have observed eelworm causing extensive gall formation and consequent pimpling and deformation of tuber surface in the potted plants of *Solanum commersonii* grown by the Botanist in his laboratories at Peradeniya. This observation will provide confirmation of the fact that *Meloidogyne javanica* infects the potato under local conditions and careful observations are necessary.

Incidentally it may be mentioned that the local potato varieties grown under the name of *S. commersonii* belong to *Solanum tuberosum* sub-species *andigenum*.

3. **Personnel**: Potato growing is a specialised art and demands a good knowledge of cultivation requirements of the crop. It will be necessary for the personnel actually engaged on potato production at field level to acquire this knowledge. The worker at field production level must be a competent "potato grower" and not only a specialist in a specific branch of agricultural science. Much of the knowledge in potato culture can be locally gathered and assimilated.

However, whatever help I could render in this regard during my short stay in the country, was made available to the technical staff during the course of field days and discussions.

4. Under the Colombo Plan two officers of the Department of Agriculture are being trained at the Central Potato Research Institute, Simla, India, and I hope the experience acquired by them would be of value to the Government of Ceylon.

Some Other Aspects of Potato Culture

1. **Time of Sowing and Harvesting**: There is very little information available as to the right time of planting and harvesting under different climatic conditions and elevations. It is very necessary that this information should be acquired and assessments made (in specific climatic regions) as to the number of crops that could be raised in a year by suitably adjusting times of sowing and harvesting. The manner in which this information could be secured was worked out at a meeting held on 31st March with the Director of Agriculture and the other specialist officers.

2. **Fertilizer Trials :** In view of the great variability of the soil types and variations in responses of N, P, K and calcium it would be desirable to organize co-ordinated fertilizer trials in potentially important potato growing areas. This information will be of help in working out fertilizer schedules for different soil types.

3. **Pests :** At present there do not appear to be any serious pests of the potato, except perhaps some ant trouble. It is desirable to direct the programme of Entomology more towards immediate problems like those connected with identification and survey of aphids and eelworms. Trials with insecticides when there are no new immediate problems of pests, are not likely to yield results of immediate practical value.

Acknowledgment

I express my deep gratitude to Hon'ble Philip Gunawardena, Minister of Agriculture and Food with whom I had the opportunity and privilege of discussing the problems of potato improvement. I have greatly benefited by these talks.

My sincere thanks are due to Dr. M. F. Chandraratne, Director of Agriculture, who took special pains to see my visit to Ceylon was both pleasant and fruitful. I am particularly grateful to him for having provided me opportunities to discuss the problems of potato growing with the specialist officers. It was through his active interest that a programme for future improvement of the potato crop in Ceylon could be framed.

Mr. A. V. Richards, Deputy Director of Agriculture, with whom I had the privilege to come in close contact has been very helpful to me in executing my work. I am very grateful to him.

My thanks are due to Dr. J. W. L. Peiris, Plant Pathologist, Dr. F. Ponnaperuma, Chemist, Dr. H. E. Fernando, Entomologist, Mr. D. V. Ariyanayagam, Botanist, Dr. D. V. W. Abeygoonewardena, Assistant Pathologist and Mr. A. C. M. Asver, Farm Manager, with whom I had opportunities to discuss the problems and programme in detail on several occasions.

Finally, I am grateful to the High Commissioner for India, Mr. Y. D. Gundevia, Dy. High Commissioner for India, Mr. B. N. Nanda, and the Secretary, Mr. A. K. Damodaram, for providing me facilities and guidance in executing my work.

CULTIVATION OF POTATOES IN CEYLON

By A. V. RICHARDS
(*Deputy Director of Agriculture*)

CEYLON'S annual imports of consumption potatoes average 750,000 cwt. valued at nearly 14 million rupees. Most of the supplies in recent years have come from Holland, Italy, Egypt and China. There are hardly any imports of potatoes into Ceylon from about May to August which is the growing season in exporting countries. Imports are heavy during the last four months of the year. It is fortunate that Ceylon is able to produce her main crop of potatoes from May to July when imports are scarce.

An acclimatised variety of potato which originally came from Uruguay has been grown on a small scale at the higher elevations in Ceylon for several decades. It was believed to be a variety of *Solanum commersonii* but has since been identified as a form of *Solanum andigenum*. The tubers are generally purplish and small in size and yields are low.

The cultivation of potato on a large scale was attempted by the Department of Agriculture in 1951-52 at Rahangala Farm near Gurutalawa at an elevation of about 4,500 feet, but the venture was a failure owing to poor organisation and incidence of bacterial wilt and other diseases. The farm was closed down after heavy expenditure had been incurred.

Attempts by the Department of Food Production to popularise the cultivation of potatoes by villagers in that area proved abortive and large quantities of seed potatoes issued for planting could not be recovered owing to crop failure.

On a directive from the Hon. Minister for Agriculture and Food the cultivation of potato was resuscitated at Rahangala in 1957. About forty acres of the available extent of the old farm, which had been alienated to colonists, were taken over, and the land prepared for cultivating potato under the direction of a Departmental Potato Committee. A Pathologist was stationed on the farm and every precaution was taken to prevent infection by Bacterial Wilt and other diseases. No implements were allowed to be brought in from outside, and the bulk of the

manure was collected locally from cattle penned on the farm or transported from the cattle farm at Ambawela. Imported seed potatoes of the following varieties were planted at Rahangala after thorough inspection and disinfection by the Pathologist in January, 1957.

Variety	*Quantity*
Great Scot	5 tons
Up-to-date	2 tons
Duke of York	2½ tons
Epicure	2½ tons
Total ..	12 tons

A basal dressing of 10 tons of cattle manure per acre was given to the multiplication plots and was followed by a fertilizer mixture consisting of 4 cwt. Sulphate of Ammonia, 2½ cwt. concentrated Superphosphate and 1 ton of Muriate of Potash, at the rate of 7½ cwt. per acre at the time of planting. The entire extent was grown under irrigation and the seed rate was 18 to 20 cwt. per acre. The following trials were set down by the specialist officers :—

Botanist :

(i) **Cultural Trial**—with 3 seed sizes and 3 distances of planting—8 in., 12 in. and 16 in. in the rows spaced 2 feet apart.

(ii) **Varietal trial**—12 varieties of which 4 were from the United Kingdom and 3 from Holland.

(iii) **Varietal cum Cultural Trial**—4 United Kingdom varieties and two types of seed tubers—sprouted and unsprouted.

Chemist :

(iv) **Fertilizer Trial**—using two varieties at 2 levels each of nitrogen (0 and 100 lb.) potash (0 and 100 lb.) phosphate (0 and 200 lb.) combined with cattle manure at 5 tons and 10 tons per acre.

Plant Pathologist :

(v) **Fungicidal Trial**—10 fungicides and unsprayed control.

(vi) **Seed Disinfection Trials**—four treatments at two concentrations of formalin, Ceresan, Dithane and Streptomycin.

Entomologist :

(vii) **Dorylus ant control**—20 insecticidal treatments.

The results of the trials indicated that spacing of 8 in. within the row gave a significantly higher yield than spacing of 16 in., there being no significant differences between the 8 in. and 12 in. spacing nor between the 12 in. and 16 in. spacing. The differences between seed sizes were not significant although there was a tendency for the larger seed to give a higher yield.

Of the varieties, *Up-to-date* significantly outyielded all others except *Alpha* and *Great Scot*, the yield expressed in tons per acre being 14.10 as against 9.38 for *Duke of York* which was about the lowest. *Duke of York* being an early variety matured in 73 days, *Epicure* in 82 days and all the other varieties in 87 days.

Hon'ble Minister for Agriculture & Food inspects Potato crops at Rahangala

In the fertilizer trials, nitrogen, phosphate and potash gave significant increases in yield, while the response to 10 tons of cattle manure as against 5 tons was barely significant. There were no significant differences in yield between *Great Scot* and *Up-to-date*.

The fungicidal treatments showed no significant differences probably because of the low incidence of disease at Rahangala. Copper

fungicides and carbamates were equally effective although in the trials at Bopatalawa only the carbamates—Dithane and Manzate—controlled Late Blight effectively. Dorylus attack being negligible, the insecticidal treatments showed no significant differences.

On the multiplication area, routine spraying with copper fungicides effectively controlled Late Blight, but sporadic cases of Bacterial Wilt occurred. The diseased plants were promptly burnt and the soil in the immediately vicinity disinfected with formalin.

The cost of cultivation per acre was about Rs. 2,500 of which the value of the seed potato alone, including transport, was nearly Rs. 1,000. The potatoes were sold to the Marketing Department at 30 cents per lb. and an average profit of about Rs. 3,000 per acre was realised in 1957. Comparable yields were also obtained at Bopatalawa and Ambawela.

A further extent of 20 acres was developed for potato at Rahangala in 1958 and two crops were produced successfully one in May-June and the other in September-October. Similarly at Bopatalawa where 100 acres were developed for potato on a directive from the Hon. Minister for Agriculture and Food, two crops were produced in 1958, one in June-July and the other in October-November. Hardly any irrigation was given as the rainfall was fairly well distributed. Certified seed potato of Dutch varieties—Gineke, Voran and Tedria—which were more resistant to Late Blight than Up-to-date were planted using a mechanical planter which could deposit both seed and fertilizer together in the rows. Seed from the first crop was used for planting the second crop in August after breaking dormancy by treatment with acetylene generated from calcium carbide.

Attempts to grow potato under sprinkler irrigation in the dry zone at Mahaillupalama and Pelwehera were unsuccessful. The high soil temperatures which prevailed here in the months of August and September retarted tuberisation, while the heavy monsoon rains in October affected the growth of the crop planted on newly cleared chena land at Pelwhera. The incidence of Bacterial Wilt was also high in the low country. Planting during the cooler months in late December-January when the heavy monsoon rains are over would probably give better results if the soil is wilt-free.

In some varieties of potato tuberisation takes place early and in others late. It is important to time the planting correctly so as to enable the crop to mature before the heavy monsoon rains, since wet weather at harvest affects the keeping quality of the tubers and tends to make them rot in the field.

Appreciable reduction in cost of production is possible if the seed potato is produced locally. Imported seed is expensive because of the high cost of refrigerated storage while in transit. Plans for the local production of seed potato were finalised in consultation with Dr. Puskarnath, Director, Central Potato Research Institute, Simla, who visited Ceylon early in 1958 under the auspices of the Colombo Plan. He was of opinion that disease-free seed could be produced at elevations above 6,000 feet at Horton Plains where the soil was likely to be free from the organism causing Bacterial Wilt and the prevailing winds would retard the movement of aphid vectors that transmit

Tractor-drawn mechanical planter

virus diseases. Eight other sites have also been selected at high elevations at Kandapola and Nuwara Eliya, and at two of these centres seed multiplication stations have already been established.

At the suggestion of Dr. Puskarnath a survey of the incidence of Bacterial Wilt, which is the chief limiting factor to the extension of potato cultivation, was undertaken in cultivators' fields on two types of land—irrigated paddy land and high land—and at three elevations. The preliminary results indicate that Bacterial Wilt hazards are very

much less at the higher elevations and on irrigated paddy land at lower elevations which do not receive enough water to cultivate paddy in *Yala* when potatoes can be grown. It is also significant that the incidence of wilt was high on unirrigable high land previously cultivated with vegetables of the family Solanaceae.

The wilt infested areas will have to be mapped out before an extension programme for potato is put into operation. As effective methods of wilt control do not exist at present, infested areas should not be planted in potatoes. The average annual imports being 750,000 cwt. of potatoes, the extent required for self sufficiency with an estimated yield of 4 to 5 tons per acre is only about 7,000 to 9,000 acres. It is fortunate that this extent of suitable land is available at the higher elevation in Ceylon.

EXPERIMENTS ON THE FUNGICIDAL CONTROL OF LATE BLIGHT OF POTATO

1. Screening of Fungicides

By D. V. W. ABEYGUNAWARDENA
(*Research Co-ordinator, Rahangala*)

and

J. W. L. PEIRIS
(*Plant Pathologist*)

LATE BLIGHT, caused by *Phytophthora infestans*, has been in the past, the most serious fungus disease limiting yields of the potato crop. Peiris and de Zilva (1954) demonstrated that significant control of the disease was possible by spraying copper fungicides. They tested the effectiveness of cuprous oxide and copper oxychloride formulations and Bordeaux Mixture, and reported that there was no significant difference between these fungicides. These results are in conformity with results obtained elsewhere (Marsh, R. W., and Martin, H. 1941 ; Beaumont, A. and Large, E. C. 1942). However, in recent years several more effective fungicides have been described (Chattopadhyay, S. B., 1952 ; Callbeck, L. C. 1956 ; Theide, H. 1956) and the main objective of the present investigation was to evaluate the efficacy of a wide spectrum of organic and inorganic fungicides in controlling late blight of potato.

Material and Methods

The fungicides screened, their active ingredients and the rates of application are listed below :

Fungicide	Active Ingredient	Rate of Application
Perenox ..	Cuprous oxide	2½ lb./100 gl.
Cupravit ..	Copper oxychloride	2½ lb./100 gl.
Bordeaux mixture ..	Copper	5–5–50

Fungicide	Active Ingredient	Rate of Application
Mercurised Copper ..	Mercury copper oxychloride ..	2 lb./100 gl.
Dithane Z–78 ..	65% Zine ethylene bisdithiocarbamate ..	2 lb./100 gl.
Dithane M–22 ..	70% Manganese ethylene bisdithiocarbamate	2 lb./100 gl.
Fermate ..	76% Ferric dimethyl dithiocarbamate ..	2 lb./100 gl.
Thiotox ..	Tetramethyl thiuram disulphide (TMTD)	10 oz./100 gl.
Karathane ..	22·5% Dinitro (1-methyl heptyl) phenyl crotonate plus Dinitro phenols and derivatives chiefly Dinitro (1–methyl heptyl phenol) 2·5%	¾ lb./100. gl.
Captan ..	N–trichloromethyl mercapto–4–cyclohexane–1, 2–dicarboximide	2 lb./100 gl.

The sprays were applied with a knapsack sprayer, care being taken to get a thorough coverage on both leaf surfaces and on other parts of the plant above ground. The average quantity of the spray used ranged from 1½ gallons at the first spraying, when the plants were small and the foliage sparse, to 3 gallons at the fourth spraying and thereafter. Movable screens were used to prevent spray drift. The sprays were continued until harvest.

The treatments were randomized and replicated 4 times. Each plot was 8′ × 40′ and consisted of 20 rows with 8 plants per row, making a total of 160 plants per plot. The 2 border rows, at each end of the plot, were rejected at harvest to eliminate possible border effect. As the crop was grown under irrigation provision was made to enable irrigation of the plots separately thereby eliminating possible flow, of the spray liquid from one plot to another. The experimental plots received the following manuring :

Cattle manure	10 tons per acre
Sulphate of Ammonia	4 cwt. per acre
Concentrated Superphosphate	2½ cwt. per acre
Muriate of Potash	1 cwt. per acre

Certified seed potatoes of the variety Great Scot were placed at spacings of 10 in. within the row and 2 ft. between rows.

The following methods were used to estimate the incidence of late blight.

1. **Estimate of Foliage Disease**. This method is essentially based on the Weber-Fuchner law which states that the visual activity depend on the logarithm of the intensity of the stimulus. In measuring potato blight, the stimulus changes at the 50 per cent level ; below 50 per cent the eye sees the diseased tissue, and above 50 per cent it sees the healthy tissue. The following, scale (Anon. 1947) was used for the measurement of potato blight.

Per Cent. Disease		*Description*
0	..	Not seen on field
0·1	..	Only a few plants affected here and there
1	..	Up to 10 spots per plant
5	..	Up to 50 spots per plant
25	..	Nearly every leaflet with lesions, plants still retaining normal form, may smell of blight but looks green although every plant is affected
50	..	Every plant affected and about one half of leaf area destroyed by blight, field looks green flecked with brown
75	..	About three-fourths of leaf area destroyed by blight ; field looks neither predominantly brown nor green
95	..	Only a few leaves left green but stems green
100	..	All stems dead or dying, leaves dead

2. **Estimate of the Reduction in Yield.** The plots were harvested separately and tuber weights taken.

Results of Experiments

Experiment 1. This was conducted at the Potato Research Station, Rahangala. The trial was planted on the 3rd of February. Nine applications were made, each plot receiving the spray once a week. The first spray was on March 7th. The trial was harvested on June 20th.

In *Maha* 1957 the weather conditions at Rahangala were not particularly favourable for the development and spread of potato blight. The efficiency ratings taken on May 1st together with yield data are presented in Table 1.

TABLE 1—Effect of Fungicides on the Control of Late Blight of Potato under Rahangala Conditions

Treatment	*Mean % Disease*	*Mean Yield (Cwt./Acre)*
Cupravit	0·075	164·43
Perenox	0·1	141·67
Bordeaux Mixture	0·075	126·40
Mercury copper oxychloride	0·1	160·97
Dithane M–22	0·075	160·43
Dithane Z–78	0	151·68
Fermate	50·0	169·35
Thiotox	72·5	139·02
Captan	20·2	162·70
Karathane	62·5	158·27
Unsprayed	97·5	141·53

Yield differences between treatments are not statistically significant. However examination of the efficiency ratings indicate that all the copper fungicides and the organic formulations Dithane Z 78 and Dithane M 22 controlled the disease satisfactorily, whereas Captan, Fermate, Karathane and Thiotox were decreasingly effective. All the fungicides tested were superior to the unsprayed plots.

Experiment 2. A parallel experiment to that described above was conducted at the Cattle Farm, Bopatalawa. Planting of this trial had to be delayed until February 25th to avoid frost. Nine spray applications were made at weekly intervals, the first spray being on March 26th. The trial was harvested on May 26th.

When the weather turned favourable for late blight, active blight lesions were scattered in the unsprayed and Fermate sprayed plots on April 3rd. Under heavy rainfall and continual damp conditions prevailing at the time of the experiment, late blight rapidly progressed into an unusually severe epiphytotic. The disease spread very rapidly through the unsprayed plots to some of the sprayed plots. This outbreak of the disease afforded an excellent opportunity to test the efficacy of the different fungicides. Spray efficiency ratings were taken on May 8th, 15th, and 22nd. The disease estimates and the yield data are presented in Table 2.

TABLE 2—Effect of Fungicides on the Control of Late Blight of Potato

Treatment	Mean % Disease on 8.5.57	Mean % Disease on 15.5.57	Mean % Disease on 22.5.57	Mean Yield (Cwt./Acre)
Cupravit	0·4	13·2	67·5	198·60
Perenox	0·4	7·0	77·5	184·44
Bordeaux Mixture ..	0·1	3·0	66·2	184·50
Mercury copper oxychloride ..	0·4	2·0	61·2	188·39
Dithane M–22.. ..	0·1	0·6	4·0	212·70
Dithane Z–78 ..	0·1	0·1	1·0	224·28
Fermate	4·0	90·0	100·0	184·88
Thiotox	26·5	96·2	100·0	190·27
Captan	6·8	15·0	72·2	201·11
Karathane	37·5	91·2	100·0	179·43
Unsprayed	61·2	100·0	100·0	172·91

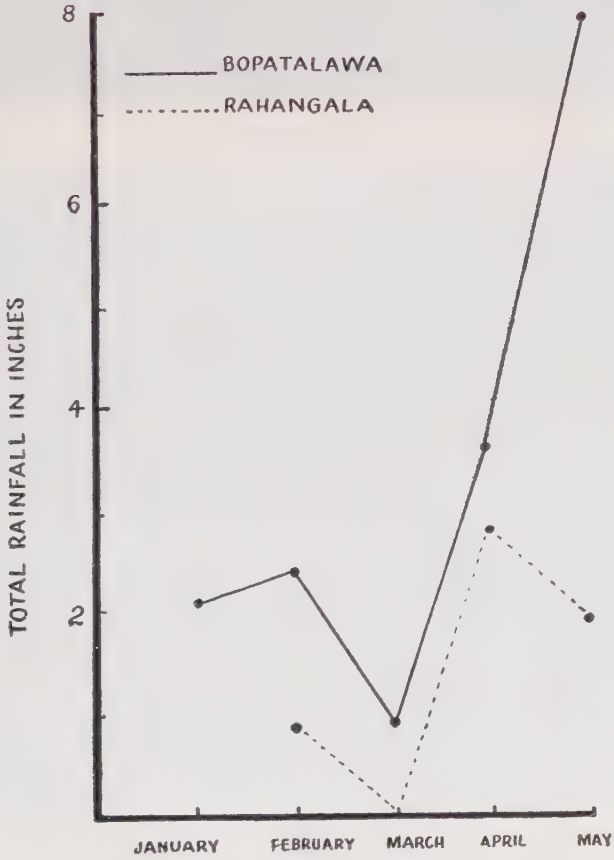

Fig. I.

Fig. 2.—Control of Late Blight with Copper Fungicides (Perenox) under conditions less favourable for disease.

Perenox sprayed (*above*) ; Unsprayed (*below*).

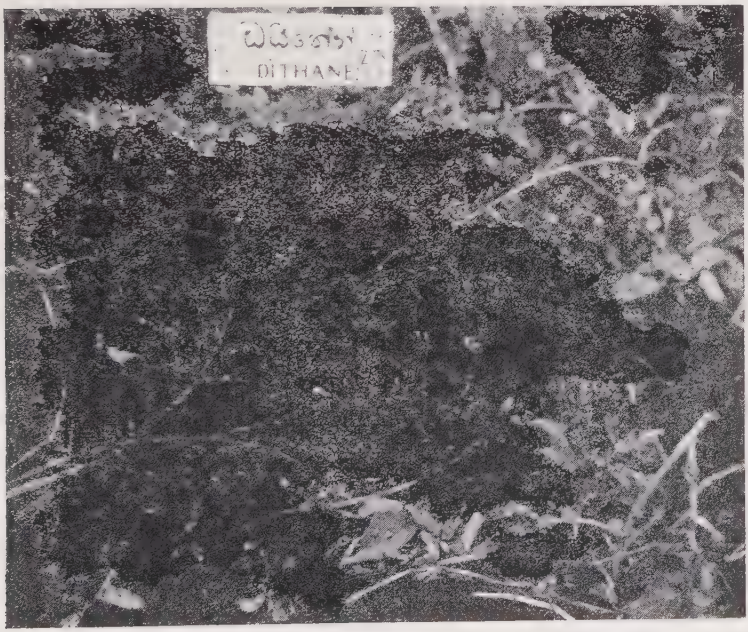

Fig. 3.—Break down of Copper Fungicides (Perenox) under epiphytotic conditions (*above*)—Note control of disease with Dithane Z 78 (*below*).

Examination of the spray efficiency data indicate that at early stages of attack all the copper fungicides and the two dithiocarbamates, Dithane M-22 and Dithane Z-78 gave satisfactory control of the disease. This result is in conformity with the efficiency ratings obtained for Rahangala ; but as the disease continued to develop into a severe epiphytotic, the efficiency of all the copper formulations and the mercurized copper oxychloride broke down rapidly, and in all these cases the disease rating was more than 50 per cent. Among the organic fungicides, all except Dithane Z-78 and Dithane M-22 failed to give effective control of the disease. The fungicides Dithane Z-78 proved the best with only 1.0 per cent of disease.

The analysis of variance of yield data is presented below. The results demonstrate that all the fungicides significantly reduced the loss of crop from late blight attack. Between the fungicides themselves, the organic fungicides were significantly more effective than the inorganic fungicides. Of the organic fungicides, the dithiocarbamates were significantly superior to the others ; Dithane Z-78 emerged as the best fungicide. The order of effectiveness of the fungicides is as follows :—

1. Dithane Z-78
2. Dithane M-22
3. Fermate
4. Captan and Thiotox
5. Karathane
6. Perenox, Cupravit, Mercurised copper, and Bordeaux mixture.

TABLE 3—Analysis of Variance

	D. F. —	S. S. —	M. S. —	F. —	0·5 Per cent point
Blocks ..	3	1,258			
Fungicides vs. Control ..	1	1,744	1,744	22·4***	4·17
Organics vs. Inorganics ..	1	928	928	11·9**	
Carbamates vs. others ..	1	1,700	1,700	21·8***	
Between Carbamates ..	2	3,302	1,651	21·1***	3·39
Between the others ..	2	903	452	5·8*	
Between Inorganics ..	3	525	175	2·2	2·92
Error	30	2,323	78		
Total ..	43	12,683			

Discussion

The data presented in Tables 1 and 2 demonstrate that late Blight of potato can be effectively controlled by fungicidal spraying under the conditions of the experiments. At Bopatawala, during the greater part of the duration of the crop, rainfall has been high—conditions extremely favourable for the development spread of *Phytophthora infestans*. Under Rahangala conditions, the disease was effectively controlled by all copper and mercurized copper formulations (see fig. 2) but the efficiency of all these copper compounds rapidly broke down in severe epiphytotic conditions obtained at Bopatalawa ; for example, Perenox which controlled disease at Rahangala failed at Bopatalawa. Plots sprayed with *Dithane Z-78*, however, survived severe infection (see Fig. 3). The yield data for Bopatalawa also indicate that *Dithane Z-78* was significantly superior to all other fungicides.

Summary

1. A range of fungicides was screened against late blight of potato both at Rahangala and at Bopatalawa.

2. According to the disease ratings obtained, all the copper fungicides and mercurized copper formulations gave satisfactory control of late blight at Rahangala where conditions were not particularly favourable for the development and spread of *Phytophthora infestans*. In an epiphytotic at Bopatalawa, the efficacy of all these formulations was considerably reduced. Among the dithiocarbamates tested *Dithane M-22* and *Dithane Z-78* gave good control of the disease at both Rahangala and Bopatalawa.

3. The yield data of the second experiment show that all spray treatments were significantly superior to the unsprayed control. The organic fungicides were superior to the inorganic fungicides ; among the organic fungicides, dithiocarbamates proved superior to others. *Dithane Z-78* was the best of the dithiocarbamates.

4. *Dithane Z-78* consistently gave the best control of late blight of potato.

REFERENCES

ANON. (1947.) The measurement of potato blight. *Trans. Brit. Mycol. Soc.*, 31, 140-141.

BEAUMONT, A. & LARGE, E. C. (1942). Potato spraying in the South West. Lessons from 1941.—*Jour. Minist. Agric*, 48.4.

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RESPONSE OF POTATO TO FERTILIZERS, MANURE, LIME, AND TRACE ELEMENTS

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THE potato crop is known to respond remarkably to nitrogen, phosphorus and potassium under temperate climate conditions. Its nutrient requirements are heavy and the income, per acre, high. These factors make it one of the most heavily fertilized crops in the world. As much as 2,500 pounds per acre of high analysis fertilizer are used in certain parts of the United States (3). The response to fertilizers varies with the variety, climate and soil conditions (2). An experiment by Kandiah and Rodrigo (1) in 1953 showed that marked responses to fertilizers can be obtained even under local conditions.

With the renewal of interest in potato cultivation in Ceylon in 1956, a series of investigations was started to study the response of potatoes to fertilizers and soil amendments at three elevations in the hill country of Ceylon. This paper reports the results of the following trials :

(i) N, P, K, cattle manure trial at Rahangala, *Maha* 1956/57 ;
(ii) N, P, K, cattle manure trial at Ambewela, *Maha* 1956/57 ;
(iii) N, P, K, cattle manure trial at Rahangala, *Maha* 1957/58 ;
(iv) N, P, K, cattle manure trial at Bopatalawa, *Maha* 1957/58 ;
(v) N, P, K, cattle manure trial at Rahangala, *Yala* 1958 ;
(vi) Liming trial at Rahangala, *Maha* 1957/58 ;
(vii) Liming trial at Rahangala, *Yala* 1958 ;
(viii) Trace elements trial at Rahangala, *Yala* 1958.

N, P, K, Cattle Manure Trial at Rahangala, *Maha* 1956/57

Rahangala is situated at an elevation of approximately 4,500 feet. The mean annual rainfall of the nearest station, Diyatalawa, is 66.5" and the mean temperature is 68° F.

The trial was set down under irrigation on a deep, well-drained, friable, sloping lateritic soil of medium texture and good structure. The soil was strongly acid and low in plant nutrients. The chemical analysis is given below :

pH	4.0
Organic matter	3.10 per cent
Nitrogen	0.09 per cent
Exchangeable bases	0.29 m.e./100m.
Exchangeable potassium	0.10 m.e./100gm.
Available P (Truog)	48 lb. per acre.

The trial was planned to test the response of two varieties of potato to nitrogen, phosphorus, potassium and cattle manure, and to study their interactions. The design was a 2^5 factorial with two replicates. Each replicate had four blocks of eight plots. The plot size was 30′ × 15′. The spacing was two feet between furrows and one foot within furrow. The varieties were "Great Scot" and "Up-to-date". The levels were :

Nitrogen ..... 0 and 100 lb. N per acre as ammonium sulphate

Phosphorus ..... 0 and 200 lb. P_2O_5 per acre as concentrated superphosphate

Potassium ..... 0 and 100 lb. K_2O per acre as muriate of potash

Cattle Manure ..... 5 and 10 ton per acre.

Manure and fertilizer were applied in the furrow on February 2, 1957. The plots were planted the next day. The plots were sprayed uniformly and regularly for disease and insect control. The plots were harvested on May 21, 1957. There were no losses due to disease or insects.

Under the soil and climatic conditions at Rahangala, nitrogen, phosphorus and potassium gave highly significant responses. The response to 10 tons per acre of cattle manure over 5 tons per acre of cattle manure was just significant at the 5 per cent level. There was no significant difference between the varieties "Great Scot" and "Up-to date". None of the two factor interactions was significant. The main effects are summarised in Table 1.

TABLE 1—Mean Yields of Potatoes in tons per acre, Rahangala, Maha 1956/57

Level	N	P	K	Cattle Manure	Significant Difference (5%)
0 ..	4·59	5·18	5·16	5·40	1·04
1 ..	7·38	6·79	6·81	6·51	
Mean response ..	2·79	1·61	1·65	1·11	1·04

The good response of potato to fertilizers at Rahangala may be ascribed to the favourable climate, the good physical characteristics of the soil and its low plant nutrient status.

The response to fertilizers and manure was highly profitable. The treatment which combined 500 lb. of ammonium sulphate, 475 lb. of concentrated superphosphate, 200 lb. of muriate of potash and 10 tons of cattle manure, per acre, gave a yield of 10.65 tons per acre or an increase of 263 per cent over the unfertilized treatment (5 tons per acre cattle manure only). This yield compares very favourably with yields in temperate countries. The increase of 7.72 tons per acre represents a net income of approximately Rs. 3,800 per acre after allowing for increased labour costs associated with fertilizer application and harvesting, with potatoes selling at 25 cts. per pound.

N, P, K, Cattle Manure Trial at Ambewela, *Maha* **1956-57**

The climate and soil conditions at Ambewela are quite different from those at Rahangala. Ambewela is cooler (elevation 6200 ft., mean annual temperature 60° F.) and wetter (mean annual rainfall 111″). The soils are friable acid loams rich in organic matter. The fairly level soil on which the experiment was set down had the following chemical characteristics :

pH	4.8
Organic matter	17.2 per cent
Nitrogen	0.43 per cent
Exchangeable bases	11.9 m.e/100 gm
Exchangeable potassium	0.25 m.e/100gm.
Available P (Truog)	116 lb. per acre

The design, varieties, kinds and levels of fertilizer and manure, as also the field operations, were exactly the same as for the experiment

at Rahangala. The plots were planted on February 26, 1957, and harvested during the period May 27—30, 1957. There was very heavy rain shortly after planting. This caused appreciable erosion losses.

Under the soil and climatic conditions at Ambewela the results were different from those at Rahangala. Nitrogen gave a highly significant response, phosphorus and potassium yielded no significant responses, and there was no significant difference between the effects of 5 tons and 10 tons per acre of cattle manure. The variety "Up-to-date" gave a significant higher yield and responded significantly better to nitrogen than "Great Scot". The main effects and the variety × nitrogen interaction are shown in tables 2 and 3.

TABLE 2—Mean Yields of Potato in tons per acre, Ambewela, Maha 1956/57

Level	N	P	K	Cattle Manure	Significant Difference (5%)
0 ..	5·48	5·81	5·77	5·96	
1 ..	6·63	6·30	6·34	6·18	0·60
Mean Response ..	1·15	0·51	0·57	0·22	

TABLE 3—Variety × nitrogen interaction : mean yields in tons per acre, Ambewela, Maha 1956/57

Variety	N_0	N_1	Significant Difference
Great Scot ..	5·57	7·44	
Up-to-date ..	5·41	5·81	0·42

The yields were generally lower, and the responses to fertilizers and manure less marked at the wet, high elevation station, Ambewela, than at Rahangala. The absence of significant responses to potassium and cattle manure may be attributed to the satisfactory levels of exchangeable potassium and organic matter, respectively in the soil. The reasons for the absence of a significant response to phosphorus are not clear for the 116 lb. per acre of available phosphorus (Truog) in the soil can hardly be considered an adequate supply.

N, P, K, Cattle Manure trial at Rahangala, *Maha* **1957/58**

The previous year's trials at Rahangala revealed a marked response of potato to nitrogen, phosphorus and potassium. There was also an indication of a response to cattle manure. But the information was of limited value owing to the absence of a third level of each of the factors. This deficiency was made good in the trial set down in *Maha* 1957/58.

The experiment was set down as a 3^4 factorial in nine blocks of nine plots each with the three factor interactions partially confounded.

The levels were:

N ..... 0, 60, 120 lb. N per	acre as ammonium sulphate
P ..... 0, 150, 300 lb. P_2O_5 per	acre as concentrated superphosphate
K ..... 0, 100, 200 lb. K_2O per	acre as muriate of potash
Cattle Manure. 0, 5, 10 tons per	acre.

The 81 plots, which had to be restricted in size to 20′ × 10′ owing to difficulties of terrain, were laid down on a moderately steep, virgin patana (grassland) soil which had the following chemical analysis:

pH	3.8
Organic matter	3.25 per cent
Nitrogen	0.12 per cent
Exchangeable bases	1.73 m.e/100 gm.
Exchangeable potassium	0.22 m.e/100 gm.
Available P (Truog)	44. lb. per acre

The fertilizers and manure were applied in the furrow and potatoes (variety, "Up-to-date") planted on February 7, 1958, and the plots were irrigated. Harvesting was done on May 28, 1958.

The responses to nitrogen, phosphorus, and cattle manure were highly significant and linear while potassium gave no significant response. None of the two-factor interactions were significant. The main effects are summarised in Table 4 and presented graphically in Fig. 1.

TABLE 4—Mean Yields in tons per acre

Levels	N	P	K	Cattle Manure	Significant Difference
0 ..	6·5	3·8	7·1	6·4	
1 ..	7·3	8·4	7·2	7·0	1·1
2 ..	7·7	9·4	7·3	8·2	

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The results of this trial confirm the earlier findings that potato responds markedly to nitrogen, phosphorus and cattle manure, at Rahangala. They differ from the results of the previous year's experiment in the following respects : (i) yields generally are higher ; (ii) the response to phosphate is very much more marked ; (iii) the response to nitrogen is smaller ; (iv) there is no significant response to potassium. These points are brought out in Table 5.

TABLE 5—Comparison of mean responses in Maha 1956/57 and Maha 1957/58 at Rahangala

Comparison	*Mean responses (tons/acre)*	
	Maha 1956/57	*Maha 1957/58*
100 lb. per acre N vs. No. N	2·8 ..	1·1
200 lb. per acre P_2O_5 vs. No. P_2O_5	1·6 ..	5·2
100 lb. per acre K_2O vs. No. K_2O	1·7 ..	0·1
5 tons per acre cattle manure vs. no cattle manure ..	1·1* ..	1·2

* 10 tons vs. 5 tons.

The marked response to phosphate may be attributed to the very low phosphate status of the soil and the phosphate loving character of the crop. The absence of a response to potassium may be related to the fairly satisfactory level of exchangeable potassium in the soil.

N, P, K, Trial at Bopatalawa, *Maha* **1957/58**

Bopatalawa is situated at an elevation of 5,000 feet. The mean annual rainfall is 81.19″ and the mean annual temperature 64° F. (computed).

The trial was set down on a sloping, black, strongly acid, friable loam with a high content of humus, which had been under natural pasture for several years. The chemical analysis is given below :

pH	4.1
Organic matter	12.3 per cent
Nitrogen	0.32 per cent
Exchangeable bases	2.51 m.e. per 100 gm.
Exchangeable potassium	0.44 m.e. per 100 gm.
Available P (Truog)	94 lb. per acre

The design was a 3^3 factorial in three blocks of nine plots each with the 3-factor interactions partially confounded with the blocks. There were two replicates. The plot size was 30′ × 15′.

The levels were :

N.....0, 60, 120 lb. N per acre as ammonium sulphate ;
P.....0, 150, 300 lb. P_2O_5 per acre as concentrated superphosphate ;
K ..... 0, 100, 200 lb. K_2O. per acre as muriate of potash.

The fertilizers were applied in the furrow and potatoes (variety "Tedria") planted on March 20, 1958. The plots were harvested on June 29, 1958.

The response to phosphorus was highly significant, that to nitrogen was significant, while the response to potassium was not significant. The main effects are summarized in Table 6.

TABLE 6—Mean yield of Potatoes in tons per acre, Bopatalawa, Maha 1957/58

Level	N	P	K	Significant Difference (5%)
0 ..	4·76	2·33	4·95	
1 ..	6·00	6·92	5·55	0·98
2 ..	5·33	6·84	5·59	

This was a repetition of the *Maha* 1957/58 trial. The designs, factors, levels, variety, plot size and field operations were the same as for the *Maha* 1957/58 experiment. The only difference was in the site of the experiment. The soil was deep, strongly acid, lateritic, sloping, of medium texture and good structure. The plots were planted on June 19, 1958, and harvested on Octobber 13, 1958.

The responses to nitrogen, phosphorus and cattle manure were highly significant. The response to potassium was non-significant. Of the interactions only the N × P interaction was significant. The yields were generally lower than for the *Maha* trials. The main effects are summarized in Table 7.

TABLE 7—Rahangala, Yala 1958

Levels	N	P	K	Cattle Manure	Significant Difference (5%)
0 ..	2·08	1·33	2·72	2·32	
1 ..	3·54	3·19	3·10	3·04	0·47
2 ..	3·04	4·14	2·83	3·30	

The figures show that there is a significant response of 1.46 tons of potatoes to a dressing of 60 lb. nitrogen per acre. The next 60 lb. of N brings about a significant decrease of 0.5 tons per acre. The response to phosphorus is very striking and linear in the range 0—300 lb. P_2O_5 per acre, the responses to 150 and 300 lb. per acre P_2O_5 being 1.86 and 2.81 tons per acre, respectively. There is a progressive increase in yield with the increase in level of cattle manure, but only the response of 0.72 tons to the single dressing of 5 tons per acre cattle manure is significant. The mean yields are presented graphically in Fig. 2.

The nitrogen × phosphorus interaction is brought out by the figures in Table 8.

TABLE 8—Nitrogen × phosphorus interaction : mean yields in tons per acre, Rahangala, Yala 1958

Lb. per acre	P_2O_5			Significant Difference 5%
	0	150	300	
N				
0 ..	1·00	2·37	2·87	
60 ..	1·25	3·60	5·21	0·81
120 ..	1·19	3·59	4·35	

The following conclusions may be drawn from Table 8 : (i) there is no significant response to nitrogen when phosphorus is absent ; (ii) in the absence of nitrogen the response to the first 150 lb. per acre of P_2O_5 only is significant ; (iii) in the presence of 60 lb. per acre N the responses to the single and double dressings of phosphorus are highly significant ; and (iv) at the 120 lb. per acre level of N, the response to 150 lb. P_2O_5 per acre is marked, while the response to the double dressing of phosphorus just fall short of significance. These points are illustrated in Fig. 3.

The results of this experiment confirm the earlier findings that under the soil and climatic conditions at Rahangala the responses are very striking in the case of phosphorus, appreciable in the case of nitrogen and cattle manure, and slight in the case of potassium. The mean responses to N, P, K, and cattle manure for the three seasons *Maha* 1956/57, *Maha* 1957/58, *Yala* 1958, at Rahangala are presented in Table 9.

TABLE 9—Mean responses (in tons per acre) at Rahangala

Comparison	Maha 1956/57	Maha 1957/58	Yala 1958
100 lb. N per acre vs. no N	2·8	1·1	1·1
200 lb. P_2O_5 per acre vs. no P_2O_5	1·6	5·2	2·7
100 lb. K_2O per acre vs. no K_2O	1·7	0·1	0·4
5 tons per acre cattle manure vs. no cattle manure ..	—	0·6	0·7
10 tons per acre cattle manure vs. no cattle manure	1·1*	1·8	1·0

* 10 tons vs. 5 tons.

In the light of the three seasons trials the following provisional fertilizer recommendation may be given for Rahangala :

500 lb. ammonium sulphate
670 lb. concentrated superphosphate
200 lb. muriate of potash
10 tons cattle manure
} per acre.

Liming Trial at Rahangala, *Maha* **1957/58**

The soils of Rahangala are strongly acid in reaction and deficient in bases. The pH value of these soils is considerably below the ideal pH range for potato which, according to Thompson (2), is 5.0 to 5.5. The acidity of these soils is aggravated by the use of the heavy dressings of ammonium sulphate necessary for high yields. A liming trial was therefore set down at Rahangala in *Maha* 1957/58.

The levels of lime were 0, 10, 20 and 30 cwt. per acre, ground dolomitic limestone. Ground dolomitic limestone was used in preference to ground coral limestone because of its higher magnesium content and ready availability.

The experiment was set down in randomized blocks of four plots each, replicated seven times, on a moderately steep soil, the characteristics of which were given under the N, P, K, Cattle Manure trial of *Maha* 1957/58. The variety used was " Up-to-date ". The plot size had to be restricted to 10′ × 8′ owing to difficulties of terrain. All plots were given the following fertilizer and manure dressing :

500 lb. ammonium sulphate
500 lb. concentrated superphosphate
200 lb. muriate of potash
5 tons cattle manure
} per acre

The plots were limed, fertilized and planted during the period February 6—7, 1958, and harvested on May 29, 1958. The mean yields and effects of lime on soil pH are shown in Table 10.

TABLE 10—Effect of lime on soil pH and potato yields, Rahangala, Maha 1957/58

Ground dolomite	pH at harvest	Mean yield (tons/acre)
0 ..	4·2	9·5
10 ..	5·0	11·0
20 ..	5·8	10·9
30 ..	6·1	10·8

The response to lime was slightly below significance at the 5 per cent level. The failure of a response of 1.5 tons per acre to attain significance was no doubt due to excessive soil heterogeneity brought about by terracing.

Liming Trial at Rahangala, *Yala* 1958

In view of the strong indications of a response to lime, the same trial was repeated in *Yala* 1958 at Rahangala on a site which permitted an increase of the plot size from 10′ × 8′ to 20′ × 10′. The design, variety, lay out, fertilizers, etc., were the same as for the previous trial except that the levels of ground dolomite limestone were 0, 5, 10 and 15 cwt. per acre and the rate of cattle manure application was 10 tons per acre instead of 5 tons per acre. The plots were limed, fertilized and planted during the period July 1—2, 1958, and harvested in October, 1958. The mean yields are shown in Table 10.

TABLE 11—Effect of lime on soil pH and potato yields, Rahangala, Yala 1958

Ground dolomite (cwt/acre)	pH at harvest	Mean yield (tons/acre)	Significant Difference 5%
0 ..	4·60	6·35	
5 ..	4·70	7·69	0·9
10 ..	4·85	8·29	
15 ..	5·05	8·37	

The response to lime was highly significant. Five hundredweight of ground dolomite gave an average increase of 1.34 tons per acre. Beyond this level of lime the responses were not significant. The effects of lime on soil pH and yields are shown graphically in Fig. 4.

The graph indicates a marked response of potato yields to lime which rapidly tapers off beyond the 10 cwt. per acre dressing of ground dolomitic limestone. The fact that a substantial increase in yield has been obtained although the pH had not changed appreciably suggests that the response has been to magnesium and possibly calcium.

These results suggest that the application of ground dolomitic limestone at the rate of 10 cwt. per acre is a necessary amendment for the acid soils of Rahangala. The benefits of liming will not be limited to the potato crop, other crops in the rotation less adapted than potato to acid soils are likely to benefit even more than the potato crop. After the initial liming of the soil, the addition of small amounts of ground dolomitic limestone to render the heavy fertilizer applications non-acid-forming is desirable. Liming beyond a pH of 5.0 appears to be unnecessary from the point of view of potato yields and is undesirable from the standpoint of scab infection.

Trace Elements Trial at Rahangala, *Yala* 1958

Though no trace element deficiency symptoms were noticed in the previous trials, it was surmized that on the strongly leached, lateritic soils of Rahangala, the supplies of available copper, boron, zinc, and molybdenum might be at threshold levels. A 2^4 factorial experiment was therefore set down at Rahangala over a basal dressing of 500 lb. ammonium sulphate, 500 lb. concentrated superphosphate, 200 lb. muriate of potash and 10 tons per acre cattle manure.

The levels were :

copper ..... 0 and 10 lb. copper sulphate per acre.
boron.....0 and 10 lb. borax per acre
zinc.....0 and 10 lb. zinc sulphate per acre
molybdenum.....0 and 1 lb. sodium molybdenum per acre

The trial was set down on June 6, 1958, and harvested on October 13, 1958.

There was no significant responses to these elements singly or in combination.

Summary and Conclusions

Fertilizer experiments with potato in the hill country of Ceylon have shown that striking increases in yield can be obtained by the use of fertilizers, manure, and lime.

On the deep, strongly acid, well drained lateritic soils of medium texture and good structure, at Rahangala, the responses to nitrogen, phosphorus, cattle manure, and lime have been spectacular. At this station, responses as high as 2.8 tons per acre to 100 lb. N, 5.2 tons per acre to 200 lb. P_2O_5, 1.8 tons per acre to 10 tons cattle manure and 1.9 tons per acre to 10 cwt. dolomitic limestone have been obtained with the variety " Up-to-date ". The response to potassium was appreciable only during one season when it was 1.7 tons to a dressing of 100 lb. K_2O per acre.

On the basis of the three seasons experiments the following provisional recommendation can be given for potato at Rahangala :

Ammonium sulphate	500 lb.	per acre
Concentrated superphosphate ..	670 lb.	per acre
Muriate of potash	100 lb.	per acre
Cattle manure	10 tons.	per acre
Ground dolomite	10 cwt.	per acre

On the acid, humic loams fairly well supplied with plant nutrients, of the cool humid stations, Ambewela and Bopatalawa, the responses to fertilizers were less conspicuous than at Rahangala. The single experiment at Ambewela showed a significant response only to nitrogen. The experiment at Bopatalawa, however, indicated clear responses both to nitrogen and phosphorus, though not to potassium, the responses to both N and 150 lb. P_2O_5 being 1.24 tons and 4.59 tons per acre, respectively, with the variety " Tedria ".

A fertilizer recommendation cannot be based on the results of a single experiment. Pending further investigations, the following mixture is recommended provisionally for Bopatalawa :

Ammonium sulphate	300 lb.	per acre
Concentrated superphosphate ..	335 lb.	per acre
Muriate of potash	100 lb.	per acre

There was a marked response to dolomitic lime at Rahangala up to 10 cwt. per acre.

There were no significant responses to copper, boron, zinc or molybdenum, at Rahangala.

Acknowledgments

Assistance received from the following officers of the Department of Agriculture is gratefully acknowledged : Mr. P. Kanapathipillai, Statistician, Dr. D. V. M. Abeygunewardena, Research Co-ordinator, Rahangala, Mr. D. M. Rodrigo, Field Assistant in soil Surveys ; and Miss S. Sivasubramaniam and other officers of the Division of Chemistry.

REFERENCES

1. Kandiah S. and Rodrigo D. M. Manurial experiment with potato at Rahangala : *Tropical Agriculturist* cx, 190-200. 1954.
2. Thompson, Homer C. Vegetable Crops, *Mc Graw Hill Book Company Inc.* (1949).
3. Smith, Ora. *Advances in Agronomy* : 1,352—390. (1949.)

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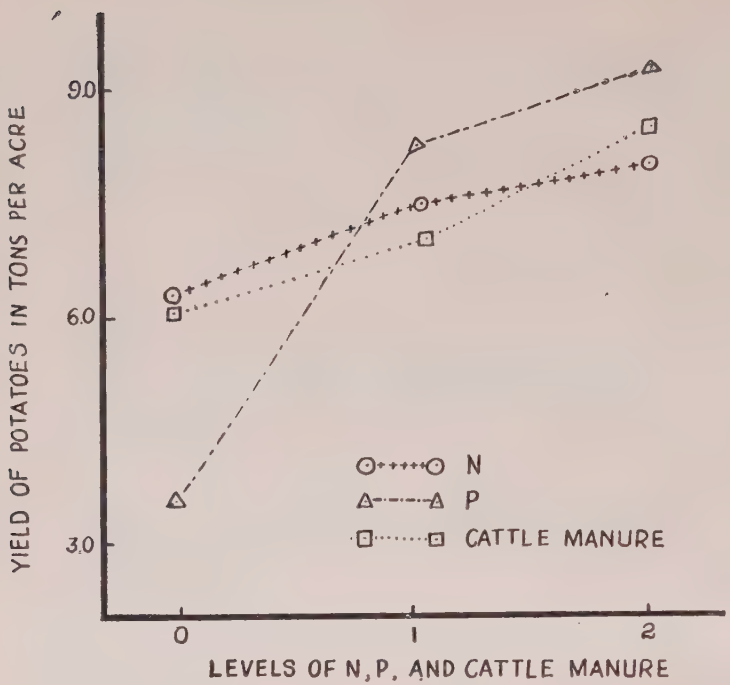
YIELD OF POTATOES IN TONS PER ACRE
9.0
6.0
3.0
0
1
2
LEVELS OF N, P, AND CATTLE MANURE
N
P
CATTLE MANURE

Fig. I.

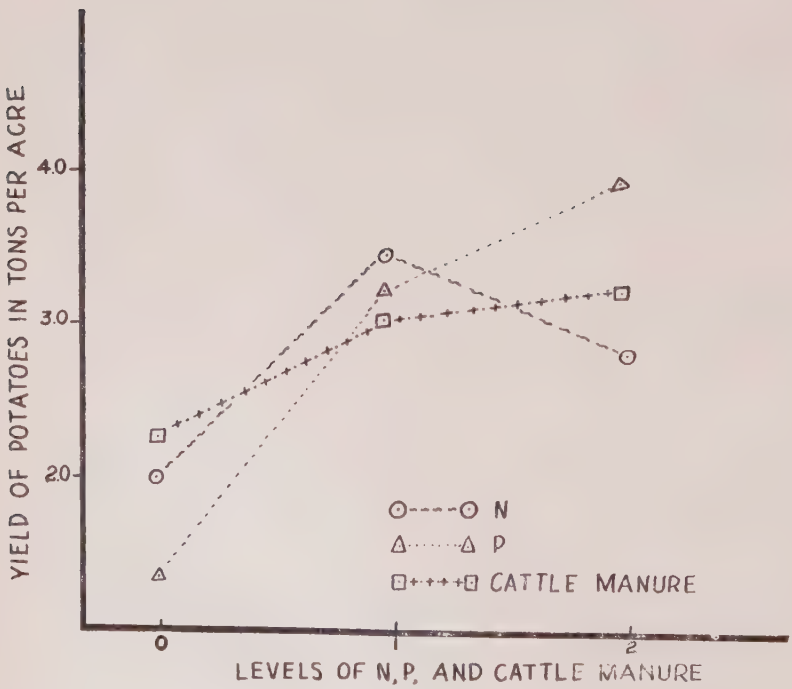
YIELD OF POTATOES IN TONS PER ACRE
4.0
3.0
2.0
0
1
2
LEVELS OF N, P, AND CATTLE MANURE
N
P
CATTLE MANURE

Fig. II.

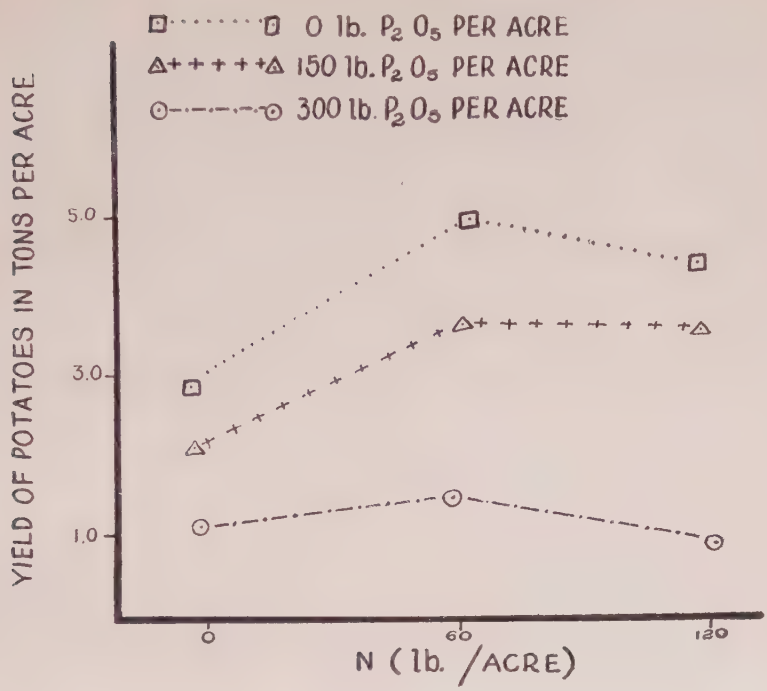

Fig III.

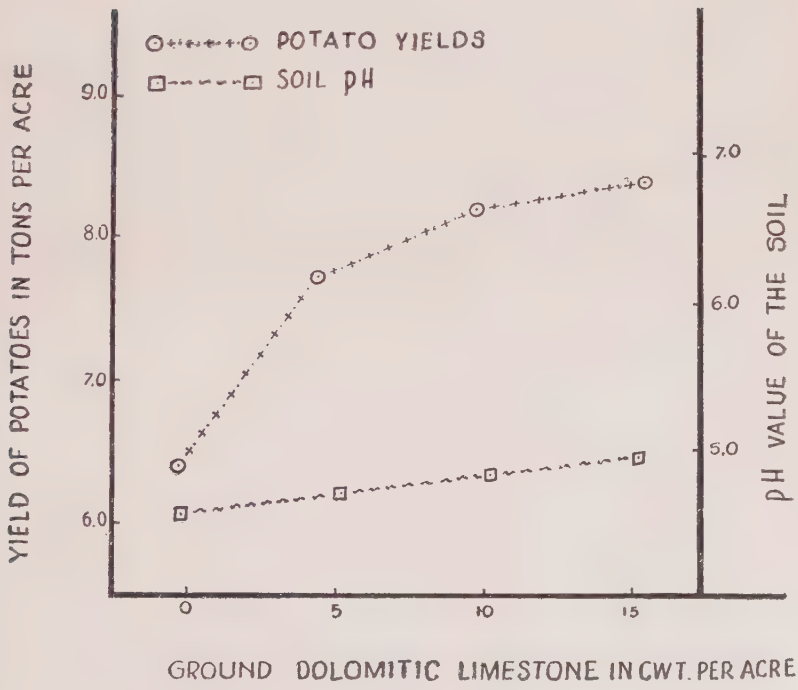

Fig IV.

6——J. N. B 11997 (2/59).

VARIETY AND CULTURAL TRIALS WITH POTATO

by D. V. ARIYANAYAGAM
(Acting Botanist and Senior Agricultural Research Officer)

EXPERIMENTAL work on potato was commenced in 1948 and continued till 1954 at Ambawela, Bopatalawa, Mahagastota, Bindunuwewa and Rahangala with varieties imported from Scotland, Canada, Holland and elsewhere. Yields of about 10 tons per acre were obtained in early years with the variety *Great Scot,* but a decline in yield caused by the soil-borne diseases, bacterial wilt and black leg, made the cultivation of this crop uneconomic, and there was a temporary cessation of experimental work in 1954. Early in 1957, however, intensive research on this crop was recommenced. The results reported in this paper relate to the trials set down in February, 1957.

VARIETY TRIALS

Trial 1

Eight Dutch and four Scottish varieties were tested in randomised blocks at Rahangala. The variety *Up-to-date* from Scotland yielded 14.10 tons per acre and significantly outyielded all other varieties except *Alpha* (a Dutch variety) and *Great Scot,* which yielded 12.86 and 12.25 tons per acre respectively. The full results are given in Table 1.

TABLE I

Variety	Yield of tubers in tons/acre
Up-to-date	14·10
Alpha	12·86
Great Scot	12·25
Gineke	11·90
Eigenheimer	11·36
Prof. Broekema	11·21

TABLE I.—(contd.)

Variety	Yield of tuber in Tons/Acre
Epicure	11·10
Tedria	10·90
Furore	10·77
Sientje	10·17
Duke of York	9·38
Profijt	9·17
(Standard Error)	(0·67)
(Significant Difference) (P = 0·05) ..	(1·94)

The variety *Duke of York* matured in 73 days, *Epicure* in 82 days and all other varieties in 87 days.

Trial II

Another experiment was carried out at the same station with the four Scottish varieties. Two types of planting material, viz.—sprouted and unsprouted tubers were used. The analysis of variance revealed that the variety differences were significant at the 0.1 per cent level. The differences due to the kinds of seed tubers and the interaction between varieties and kinds of seed tubers were non-significant. The variety yields are in Table II.

TABLE II

Variety	Yield of tubers in tons/acre
Up-to-date	13·11
Great Scot	11·36
Epicure	10·46
Duke of York	8·78
(Standard Error)	(0·28)
(Significant Difference) (P= 0·05) ..	(0·80)

These four varieties occupied the same relative positions as in the former trial, but the yields were slightly lower. The variety *Up-to-date*, however, significantly out yielded *Great Scot* in this experiment.

Trial III

The same four varieties were used in another experiment planted at Bogoliubowo. The varieties were combined factorially with two spacings viz. 8 in. and 12 in. in the row. The varieties and spacing reached significance at the 1.1 and 1 per cent levels respectively. The interaction was not significant. Table IV gives the full results of the experiment.

TABLE III

Factor	Yield of tubes in hundredweight
Variety*	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Duke of York	[illegible]
(Standard Error)	[illegible]
(Significant Difference)	[illegible]
[illegible]	
Spacing†	
[illegible]	[illegible]
[illegible]	[illegible]
(Standard Error)	[illegible]
(Significant Difference)	[illegible]
[illegible]	

* Significant at the 0.1% level.
† Significant at the 5% level.

In this experiment also, the varieties followed the same order in respect of yield, but there were no significant differences between the first three varieties, and all of them outyielded the variety Duke of York significantly.

It should be stated, that in these experiments, which physiological measures were adopted to prevent the occurrence of early and late blight. Under such conditions, there appeared to be little doubt that, of the varieties tested, Up-to-date was the most suitable. Later work had, however, shown that this variety was extremely susceptible to the late blight. The Dutch variety Tadina which yielded 11.88 tons per acre in Trial I was, on the other hand, much less susceptible.

CULTURAL TRIAL

Trial IV

A cultural trial designed to test the effects on yield of four seed sizes and three spacings within the row was carried out at Rahangala. The variety used was *Great Scot,* and a spacing of two feet between rows was adopted. The four seed sizes tested were small seed ($1\frac{1}{4}$ in.—$1\frac{3}{4}$ in. in diameter), large seed ($1\frac{3}{4}$ in.—$2\frac{1}{4}$ in.), small ware ($2\frac{1}{4}$ in.—$2\frac{1}{2}$ in.) and large ware ($2\frac{1}{2}$ in.—3 in.). The spacings within the rows were 8 in., 12 in. and 16 in., one whole tuber being planted per hill. The results are presented in Table IV.

TABLE IV

Factor	Yield of tubers in tons/acre			
	Ware	Seed	Chat	Total
*Seed Size**				
Small seed ($1\frac{1}{4}''$–$1\frac{3}{4}''$)	1·76	6·11	1·47	9·34
Large Seed ($1\frac{3}{4}''$–$2\frac{1}{4}''$) ..	1·56	6·66	1·63	9·85
Small ware ($2\frac{1}{4}''$–$2\frac{1}{2}''$) ..	1·56	6·82	1·96	10·34
Large ware ($2\frac{1}{2}''$–$3''$)	1·19	7·46	1·91	10·56
(Standard Error)	—	—	—	(0·32)
(Significant Difference) ..	—	—	—	(0·94)
*Spacing**				
8 inches	1·27	7·35	1·97	10·59
12 inches	1·71	6·77	1·63	10·11
16 inches	1·57	6·15	1·63	9·35
(Standard Error)	—	—	—	0·28
(Significant Difference) ..	—	—	—	0·81

* Significant at the 5 per cent. level.

The variance analysis of the results showed that both factors were significant. The spacing of 8 in. within the row was significantly superior to that of 16 in. The yield differences between the 8 in. and 12 in. spacings and also between the 12 in. and 16 in. spacings were non-significant. The effect due to seed size was partitioned into the linear component and the rest. The linear effect was significant. Planting ware-size tubers gave significantly higher yields than planting small seed-size tubers. The interaction between seed size and spacing was not significant.

Fig. I illustrates the relationship between yield and spacing in Trials III and IV carried out at Bopatalawa and Rahangala respectively. In the trial at Bopatalawa the 8 in. spacing gave a significantly higher yield than the 12 in. spacing. Within the limits tested, increase in spacing within the row decreased the yield.

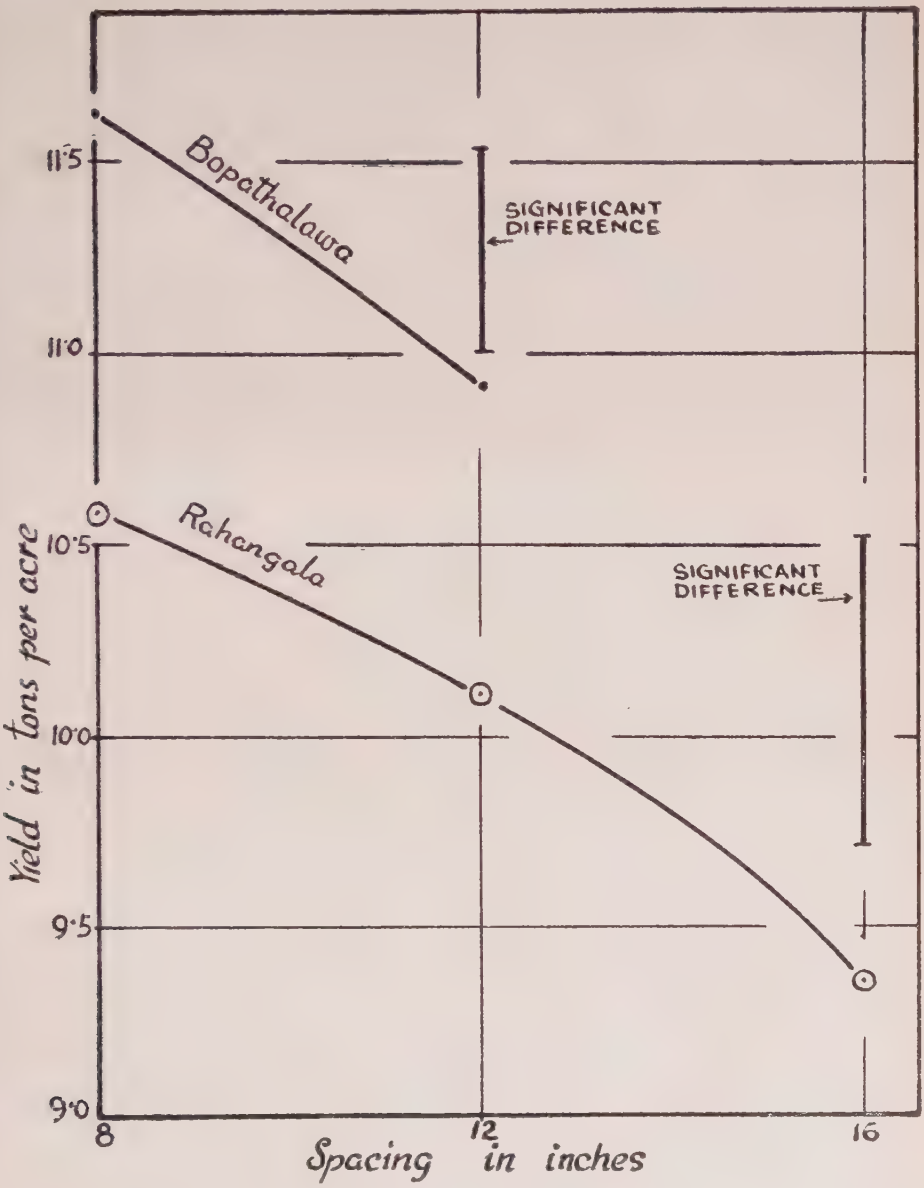

Fig. I.

Fig. II illustrates the relationship between yield and seed-size in Trial IV. It was observed that, within the limits tested, the larger the size of seed potato planted, the greater was the total yield. It was also observed that the yield of ware-size potatoes (i.e. tubers over $2\frac{1}{4}$ in. in diameter) decreased with increase in seed-size. It followed that the percentage ware in total yield also decreased with increase in seed size. For instance, when small seed was planted, 18.7 per cent. of the produce was ware, whereas when large ware was planted, the produce consisted of only 11.3 per cent. ware. The effect of spacing on ware yield was also opposite to its effect on total yield, wider spacing tending to produce more ware. The percentage ware in the produce at 8 in., 12 in. and 16 in. spacings were 12.0, 16.8 and 16.8 respectively at Rahangala. The same trend was observed in Trial III in respect of all four varieties.

From survey of potato yields in England and Wales, and from investigations of seed rate over a period of twenty years, Boyd and Lessells (1) concluded that provided the optimum seed rate was

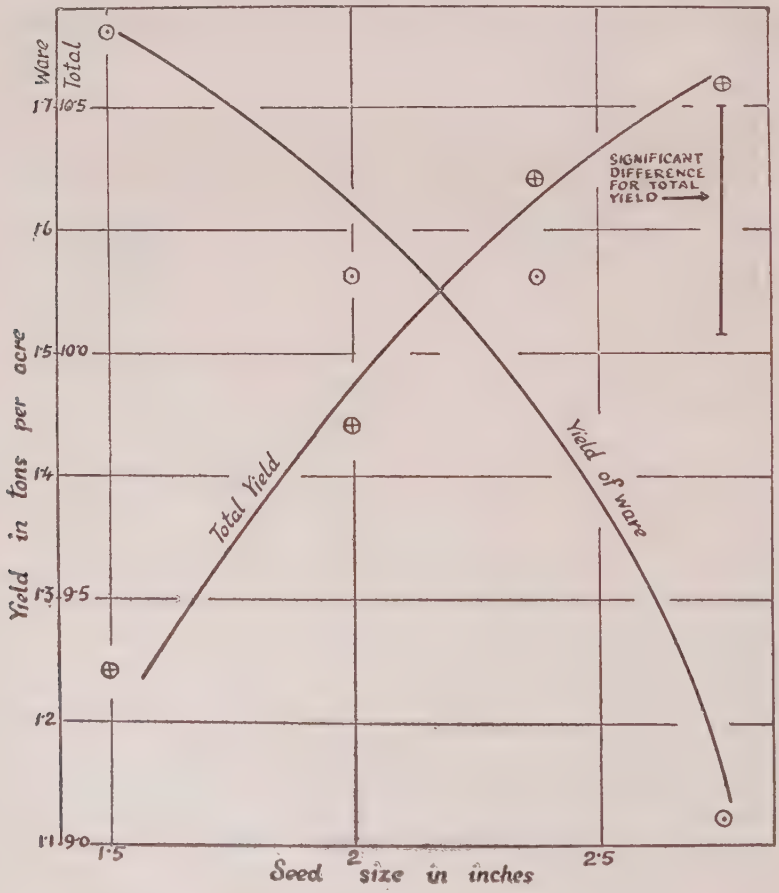

Fig. II.

attained, the precise combination of seed size and spacing (subject to an upper limit) appeared to be of minor importance. The results of Trial III support this view. The quantity of seed planted per acre, i.e., the seed rate, is determined by three factors: the average size of tuber, the spacing of tubers within the row and the distance between rows. In the present experiment, the distance between rows was kept constant at two feet. Thus the seed rate was determined by the two factors studied—viz. seed size and spacing within the row. The examination of the data on seed rate showed that a direct relationship existed between the seed rate and yield—the yield increasing with increase in seed rate. Graphically, this relationship is illustrated in Fig. III.

This curve was fitted from 12 points which represent the yields obtained as a result of all possible combinations of four seed sizes and three spacings. The curve indicates that the yield is determined primarily by the seed rate, i.e. the weight of seed planted. Since the 12 points fit reasonably well, into the curve the precise combination

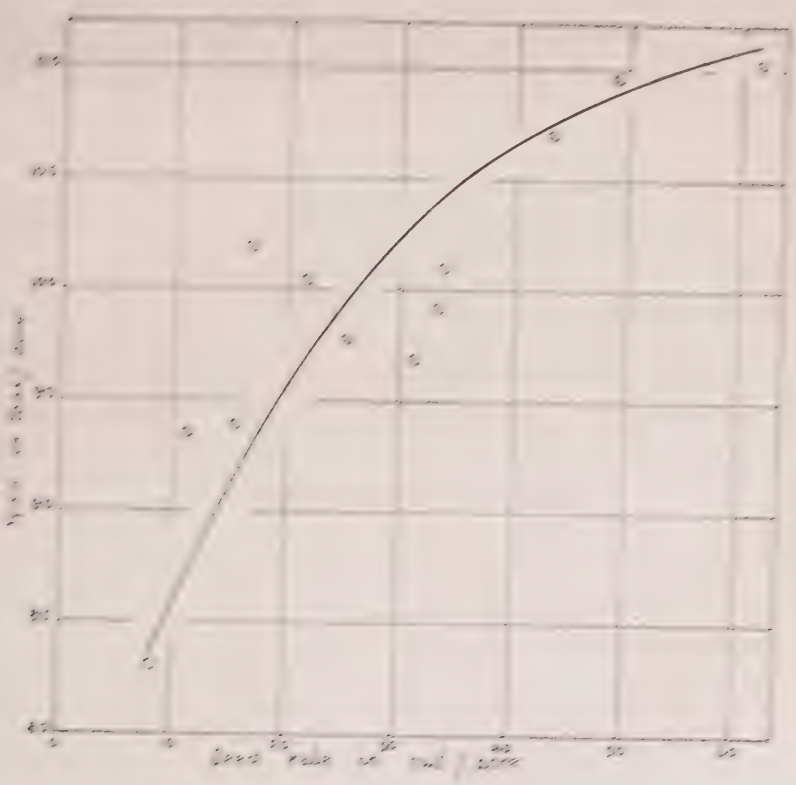

Fig. III.

of seed size and spacing distance within the limits tested, appears to be of minor importance in determining the yield. The curve, however, is not linear. The increase in seed rate increases yield, but the increment falls off as the seed rate rises. Between the seed rates of 25 and 35 cwt. per acre the increase in yield (i.e. 0.5 ton) just equals the extra seed planted, whereas above 35 cwt. the increase in yields is less. There is thus an optimum seed rate, above which the yield increase does not compensate the expenditure on seed.

This optimum seed rate depends on several factors, chief among which are the cost of seed, the value of the produce, the variety and the fertilizer practice adopted. Under the conditions of this experiment taking the cost of seed as 45 cents per lb. and the value of the produce as 30 cents per lb., the optimum seed rate works out to approximately 16 cwt. per acre.

It was stated earlier that the yield of ware-size tubers decreased with increase in seed size and with closer spacing. These two factors, of course, increase the seed rate and, therefore, it is reasonable to expect that increase in seed rate reduces the yield of ware. This trend, in fact, was observed in the experiment. The optimum seed rate from the point of view of total yield, therefore, is not necessarily the optimum for ware production.

STORAGE TRIAL

Trial V

A trial was commenced in June 1957 to determine the loss in weight of freshly harvested tubers under storage conditions at Rahangala. Four varieties, viz. *Great Scot, Duke of York, Epicure* and *Up-to-date* and three tuber sizes, viz.—ware, seed and chat—were investigated factorially. There were three replicates and ten pounds of tubers were used for each treatment. The tubers were stored in a single layer in well-ventilated trays. The weight of tubers in each treatment was taken at weekly intervals for a period of 28 weeks. Rotten tubers were discarded at each weighing. At the end of six months, the results were subjected to an analysis of variance and it was found that both the varietal differences and those due to tuber size were significant at the 0.1 per cent. level. The variety *Duke of York* stored best, followed by *Up-to-date, Great Scot* and *Epicure* in that order. With regard to tuber size, it was found that the smaller the tuber, the better it stored. Significant differences existed between any two varieties and between any two tuber sizes.

The weight of the tubers taken at weekly intervals in respect of varieties and tuber sizes are represented diagrammatically in Figs. IV and V respectively.

SUMMARY

1. The variety *Up-to-date* gave the highest yields in variety trials conducted at Rahangala and Bopatalawa.

2. The total yield increased with (*a*) closer spacing (*b*) increase in seed size and (*c*) increase in seed rate.

3. The yield of ware decreased with (*a*) closer spacing (*b*) increase in seed size and (*c*) increase in seed rate.

4. The results support the view that the total yield is determined primarily by the seed rate, the precise combination of spacing and seed size being of minor importance.

5. An investigation on storage showed that (*a*) the variety *Duke of York* stored best and (*b*) the smaller the tuber, the better it stored.

ACKNOWLEDGMENTS

The writer is grateful to Messrs. R. Wijesuriya, M. C. M. Mustapha and M. E. R. Pinto for their assistance in the field and to Messrs. S. H. Charles, B. N. Emerson and S. A. P. Wijeweera for their help with the calculations and graphs.

REFERENCE

Boyd, D. A., and Lessells, W. J.—The effect of seed rate on the yield of potatoes. *J. Agric. Sci.* 44, 465-476 (1954).

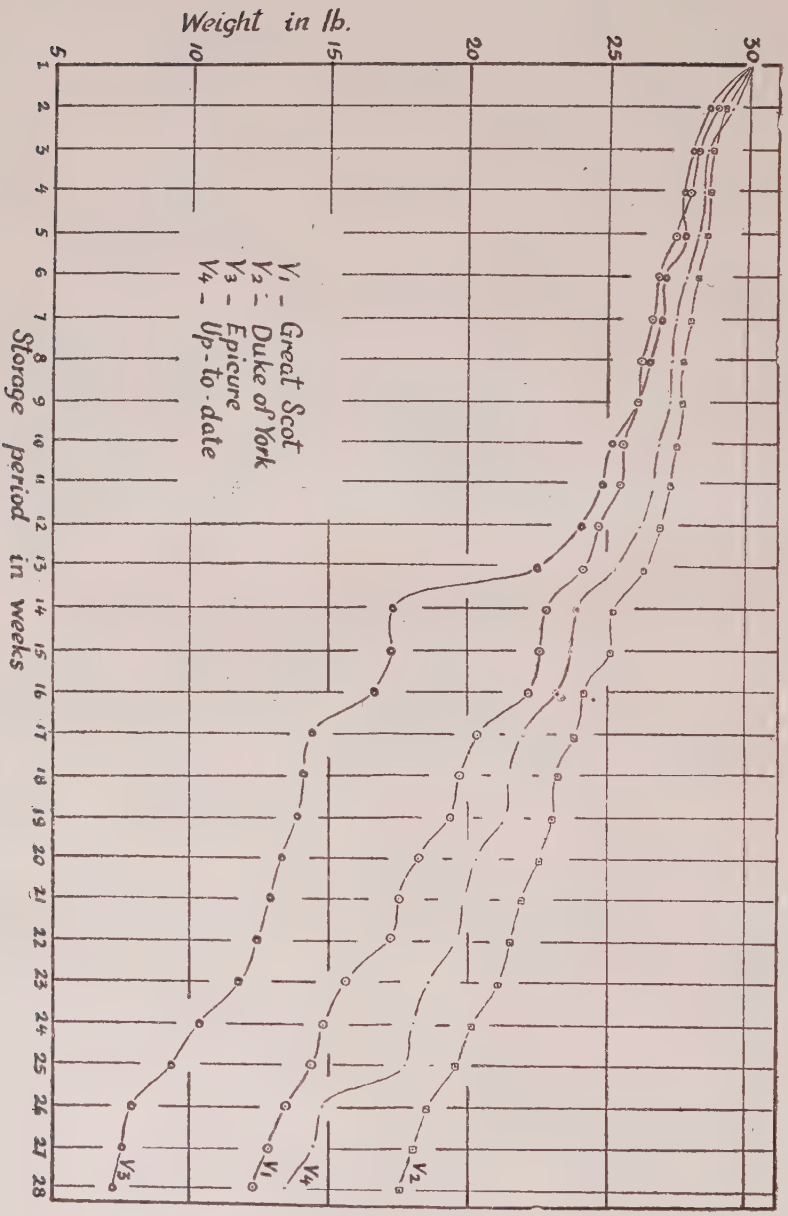
Weight in lb.
5
10
15
20
25
30
Storage period in weeks
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
V1 - Great Scot
V2 - Duke of York
V3 - Epicure
V4 - Up-to-date
V3
V1
V4
V2

Fig. IV.

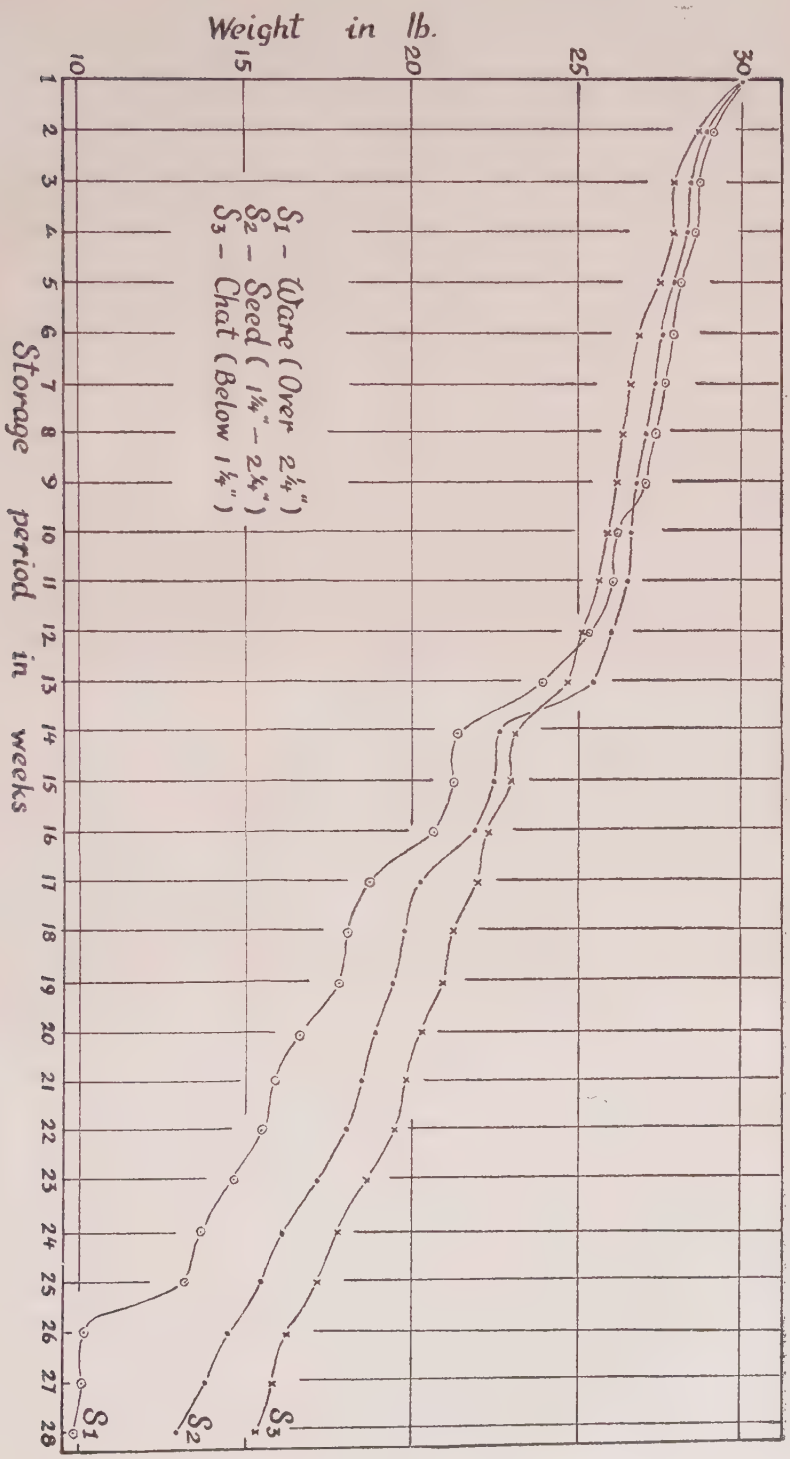
Weight in lb.
10
15
20
25
30
Storage period in weeks
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
S1 - Ware (Over 2¼")
S2 - Seed (1¼" - 2¼")
S3 - Chat (Below 1¼")
S1
S2
S3

Fig. V.

INVESTIGATIONS ON POTATO INSECTS AND THEIR CONTROL WITH SPECIAL REFERENCE TO DORYLUS ORIENTALIS

By H. E. FERNANDO
(*Entomologist*)
and
P. MANICKAVASAGAR
(*Assistant in Entomology, Department of Agriculture, Peradeniya*)

POTATO was cultivated on a trial basis in and around Rahangala during the years 1952-54. During that period the chief insect pests observed on the crop were the root-eating ant *Dorylus orientalis*, the potato tuber moth *Gnorimoschema operculella*, the potato leafhopper, probably *Empoasca fabae* and the cutworm, *Agrotis-ypsilon*. One species of aphid *Mysus persicae* and a root eating termite appeared in very small numbers. With the renewed interest taken by the Department of Agriculture in potato cultivation in 1956, a survey of insect pests present on this crop was made and insecticidal studies were conducted on the control of the *Dorylus* ant and the cutworm *agrotis ypsilon* which were expected to affect the crop seriously. This paper presents the results of these studies.

Insect Pest Survey

A purely qualitative survey of insect pest incidence on the potato crop was carried out at Bopatalawa, Rahangala, Ambewela, Bindunuwewa and Nuwara Eliya in the first plantings of the crop in 1956-57. Table I gives the results of this survey which was done at monthly intervals. The cutworm *Agrotis ypsilon* while being present in all the five areas was especially destructive at Ambewela, Bopatalawa and Nuwara Eliya. The root eating ant *Dorylus orientalis* was a serious pest at Bindunuwewa. All the other insects were of minor importance on the 1956-57 potato crop. The absence in

this survey of the tuber moth *Gnorimoschema operculella* and leaf hopper *Empoasca sp.* which were major pests in the previous plantings is not understood. In the 1957-58 plantings of potato, however, the tuber moth *Gnorimoschema operculella* and an aphid *Myzus persicae* made their appearance in fair numbers at Bindunuwewa, Rahangala and Bopatalawa while *Dorylus* ant attack was severe at Bindunuwewa and Rahangala.

Plate I.—Potato tuber showing damage to cutworm. A mature cutworm is seen resting within one of the cavities in the tuber caused by its feeding.

The Cutworm, Agrotis ypsilon

The heavy infestation of the potato crop at Bopatalawa and Ambewela by cutworms in the 1956-57 planting necessitated immediate evaluation of insecticidal treatments. The insecticides endrin, aldrin and chlordane were tested as emulsions for soil treatments against this pest. The three insecticides all in the 20 per cent emulsifiable concentrate formulation were used at one of two dilutions viz. 1 fl. oz. in 2½ gallons or 1 fl. oz. in 10 gallons. Each plant received 400 cc. of the

prepared insecticidal fluid poured along the main stems into the soil. These treatments gave either ¼ lb. or 1 lb. of active ingredient of insecticide per acre. Table II gives the results of this test. All three insecticides even at the lower concentrations gave very good control.

The Root-eating Ant, Dorylus orientalis

In the first season's planting in 1957 the insecticides dieldrin, aldrin, chlordane and D. D. T. were tried out at two concentrations and two frequencies of applications. The treatments were carried out either at sprouting or both at sprouting and when tuber formation was commencing. Each planting site received 400 cc. of prepared spray fluid by pouring, and treatment was at the rate of about

Plate 2.—Potato tubers showing light damage or "pitting" caused by an attack of the root-eating ant, *Dorylus orientalis.*

400 gallons of spray per acre. Dieldrin, aldrin and chlordane were therefore used at the rate of ½ and 2 lb. of active ingredient per acre, and D. D. T. at 2 and 4 lb. of active ingredient per acre. Table III gives the results of this trial.

The incidence of the pest was markedly low throughout the trial, the maximum damage being 6 per cent in one set of check plots. Chlordane, aldrin and dieldrin were effective against the pest, with chlordane giving the best results. Only chlordane among the test treatments gave a distinct off-flavour to the potatoes. This insecticide in spite of the good ant control results it gives, cannot therefore be recommended.

A second series of insecticidal investigations for the control of *Dorylus orientalis* were laid out at Rahangala and Bindunuwewa in the first season of 1958. The variety of potato used in the trial was Epicure planted in plots of 15 ft. × 10 ft. dimensions. There were 13 plots in each of 4 replications in each trial. Seventy-five tubers were used for each plot. The insecticides used in these investigations were aldrin and dieldrin at ½ lb. and 2 lb. of active ingredient per acre and D. D. T. at 2 lb. and 4 lb. of active ingredient per acre.

They were diluted in water at the following rates for application at the rate of 8 fluid ounces of the prepared liquid per planting site :—

(1) *Aldrin 20 per cent Emulsifiable Concentrate*

(*a*) 1 fl. oz. in 5 gallons water
(*b*) 1 fl. oz. in 20 gallons water

(2) *Dieldrin 20 per cent Emulsifiable Concentrate*

(*a*) 1 fl. oz. in 5 gallons water
(*b*) 1 fl. oz. in 20 gallons water

(3) *D. D. T. 18 per cent Emulsifiable Concentrate*

(*a*) 1 fl. oz. in 2½ gallons water
(*b*) 1 fl. oz. in 5 gallons water.

Application of these treatments was at one of two frequencies viz. either at sprouting of the shoots above soil level or both at sprouting and at the stage of tuber formation. The insecticidal fluid was poured into the soil at the rate of one cigarette tin full along the basal part of the stems of the plants. The results of these trials are presented in Tables IV and V.

Statistical analysis of the data obtained in the *Dorylus* ant control trial at Rahangala showed that the treatments viz. insecticides, periodicity, and concentration were highly significant from the control.

Among the treatments, there was no significant effect between treatment at sprouting and treatment at both sprouting and tuber formation.

	Aldrin	*Dieldrin*	*DDT*	*Control*	*Significant Difference*
Mean % attacked by *Dorylus* ..	1·3 ..	3·7 ..	5·0 ..	35·3 ..	0·49

Here as in Bindunuwewa, aldrin proved the best insecticide followed by dieldrin and D. D. T.

	Low concentration (½ *lb./acre*)	*High concentration* (*2 lb./acre*)
Mean % attacked by *Dorylus* ..	4·6 ..	2·3

Here also treatment at a concentration of 2 lb. per acre had reduced the per cent attack to about half of what treatment at a concentration of ½ lb. per acre could bring about.

Analysis of the data obtained in the *Dorylus* ant control trial conducted at Bindunuwewa showed that all three treatments viz: insecticides, periodicities, and concentrations gave highly significant reduction in the percentage of attacked potatoes as compared with the control.

	Aldrin	*Dieldrin*	*DDT*	*Control*	*Significant Difference*
Mean per cent. attacked by *Dorylus* ..	4·1 ..	4·6 ..	7·3 ..	19·6 ..	0·35

Aldrin was significantly the most effective insecticide followed by dieldrin and D. D. T.

	Treatment at sprouting	*Treatment at sprouting and at tuber formation*
Mean per cent. attacked by *Dorylus*	6·6 ..	4·1

The treatment at both sprouting and at tuber-formation was significantly superior to treatment at sprouting only.

	Low concentration ½ lb. acre	*High concentration* (*2 lb./acre*)
Mean per cent. attacked by *Dorylus*	6·5 ..	4·2

Treatment at the high concentration i.e. 2 lb./acre, was significantly better than the treatment at the low concentration of ½ lb/acre.

Discussion

A survey of pest intensity in the various potato growing areas of Ceylon has shown that the root-eating ant *Dorylus orientalis* and the cutworm, *Agrotis ypsilon* are major pests of the crop. The tuber moth *Gnorimoschema operculella* which was a serious pest in the 1951-54 potato plantings did not appear on the 1956-57 crop but was present in considerable numbers on the 1958 crop. The tuber moth *Gnorimoschema operculella* is readily controllable by the use of sprays of insecticides such as DDT. One aphis, *Myzus persicae,* has been identified from Rahangala and aphids have been observed on the potato crop wherever it has been grown so far. While aphids are readily controllable by the use of organophosphorus insecticides, their abundance, movements and control even in very low population densities are of special significance where a program of potato seed propagation is being practised.

Some studies have been conducted on the control of existing heavy infestations of the cut worm *Agrotis ypsilon.* The results of these studies indicate that chlordane, aldrin and dieldrin applied in liquid form at active ingredient rates of either ½ lb. or 2 lb. per acre gave very satisfactory control of existing infestations of cutworms. Further work on the prevention of attacks by this pest by spray treatments which could fit in with a routine spray schedule for potato pest and disease control is required.

In the studies on the control of the *Dorylus* ant the first trial conducted in 1956-57 gave positive results but the rate of infestation of tubers was considerably lower than expected. This trial showed that aldrin, dieldrin and chlordane could give satisfactory control of this soil infesting pest but that chlordane was not of practical value for this purpose because it causes tainting of the potatoes. DDT used at higher dosages than aldrin and dieldrin gave much poorer control.

The studies on *Dorylus* ant control conducted at Rahangala and Bindunuwewa in the 1958 planting season yielded valuable data. The design of the insecticidal trial and the treatments involved in the two sites were identical in the two areas except for the fact that at Bindunuwewa the treatment at tuber formation time was repeated.

The results obtained at Rahangala showed that aldrin was the most effective insecticide against the *Dorylus* ant followed by dieldrin and DDT. At Rahangala, while there was no significant difference between treatment at sprouting time alone and treatment both at sprouting and at tuber formation, the application of the insecticide at the rate of 2 lb. of active ingredient per acre gave significantly better results than when applied at ½ lb. per acre.

In the Bindunuwewa *Dorylus* ant control studies the results followed the same lines as those obtained at Rahangala but here a significant difference was noted between treatment at sprouting alone and treatments at sprouting and at tuber formation. This difference in results is related to the fact that at Bindunuwewa the treatment was repeated at tuber formation. Whereas there was no significant difference in results achieved in *Dorylus* ant control between the use of aldrin at 2 lb. per acre and at 4 lb. per acre a significant difference in the results was obtained where aldrin was used at 2 lb. per acre and at 6 lb. per acre.

The results of the *Dorylus* ant control trials showed no relationship between yield and insecticidal treatment. Examination of the attack by this pest during the 1958 season showed that the pest had appeared on a large scale only when the tubers were maturing and that the attack was one of short duration. Consequently the damage by the pest did not influence yield but greatly influenced the quality and the market value of the potatoes, 35 per cent. of which were pitted by *Dorylus* ant feeding in the untreated plots. The yield as well as the quality of potatoes could be greatly influenced by *Dorylus* ant attack if the pest appears earlier in the season and damages the crop by root and stem feeding resulting in death of plants, or by prolonged attack and gallery formation on the tubers resulting in secondary rotting of tubers.

Summary

(1) A survey of the insects damaging potato during the 1956-57 planting has shown that the cutworm, *Agrotis ypsilon* and the root-eating ant *Dorylus orientalis* are major pests of this crop.

(2) Aphid populations though present in all potato growing areas, have been very low in the seasons of planting since 1956.

(3) The potato tuber moth *Gnorimoschena operculella* was found to reassert itself as a major pest of potato in 1958.

(4) Insecticidal trials have provided effective methods for the control of existing infestations by cut worms.

(5) Insecticidal trials using aldrin, dieldrin, chlordane, and DDT as soil treatments for the control of *Dorylus orientalis* showed that the former three insecticides gave good control of the pest but that chlordane tainted potatoes.

(6) Further insecticidal trials with aldrin, dieldrin and DDT showed that aldrin was superior to the other insecticides for the control of *Dorylus orientalis.*

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BIBLIOGRAPHY

BINGHAM, C. T. (1903) Fauna of British India, Hymenoptera Vol. II, pp 1-5.

GREEN, E. E.—Note on *Dorylus orientalis* Westw. Indian Museum Notes Vol. V, p. 39.

HUTSON, J. C. (1933). Entomological Notes. The root-eating ant (*Dorylus orientalis* Westw.). *Trop. Agric.* Vol. LXXX, pp. 276-279.

HUTSON, J. C. (1936). Entomological Notes. The root-eating ant (*Dorylus orientalis* Westw.). *Trop Agric.* Vol. LXXXVII, pp. 293-295.

TABLE I—Results of pest survey carried on potato crop during Maha 1956–1957

Pests	Potato growing areas and pest incidence				
	Bopatalawa	Rahangala	Ambewela	Bindunuwewa	Nuwara Eliya
Agrotis ypsilon Cutworm	+	+	+	+	+
Dorylus orientalis Dorylus Ant	+	+	—	+	—
Myzus persicae etc. Aphids	+	+	+	+	+
Nazara viridula green bug	+	+	—	+	—
Mirid bugs *	+	—	—	—	—
Bemisia inconspicua White flies	+	—	—	+	+
Hemitarsonemus latus Mites	+	+	—	—	—
Beetles*	+	—	—	—	—
Leaf eating caterpillars*	—	—	—	+	—
Pseudococcus citri Mealy bugs	—	—	—	+	—

* Unidentified.

\+ Pest present.

— Pest absent.

TABLE II—Action of insecticides poured into soil at planting site for control of the Cutworm Agrotis ypsilon

Insecticide	Dilution	Number of Plants cut by Cutworms			
		Immediately before treatment	24 hours after treatment	48 hours after treatment	72 hours after treatment
Aldrin 20% E. C.	1 fl. oz. in 2½ gallons	78	6	0	1
		168	5	2	0
	1 fl. oz. in 10 gallons	85	9	1	1
		80	0	2	0
Endrin 20% E. C.	1 fl. oz. in 2½ gallons	156	7	3	0
		62	3	1	0
	1 fl. oz. in 10 gallons	22	5	3	0
		69	4	1	0
Chlordane 20% E. C.	1 fl. oz. in 2½ gallons	81	4	0	0
		95	1	1	0
	1 fl. oz. in 10 gallons	22	2	1	0
		70	6	0	1
Check	—	78	24	39	42

TABLE III—Effects of soil insecticidal treatments on the control of Dorylus Orientalis—Rahangala 1956–57

Insecticide	Timing of treatment	Dilution	Average per cent. Weight of Ant Damaged Tubers
Dieldrin 20% E. C. ..	At Sprouting	1 fl. oz. in 20 gallons	0·76
		1 fl. oz. in 5 gallons	0·23
	At Sprouting and at Tuber Formation ..	1 fl. oz. in 20 gallons	1·80
		1 fl. oz. in 5 gallons	0·70
Chlordane 20% E. C. ..	At Sprouting	1 fl. oz. in 20 gallons	0·36
		1 fl. oz. in 5 gallons	0·56
	At Sprouting and at Tuber Formation ..	1 fl. oz. in 20 gallons	0·56
		1 fl. oz. in 5 gallons	0·60
Aldrin 20% E. C. ..	At Sprouting	1 fl. oz. in 20 gallons	1·63
		1 fl. oz. in 5 gallons	0·53
	At Sprouting and at Tuber Formation ..	1 fl. oz. in 20 gallons	0·86
		1 fl. oz. in 5 gallons	0·56
D. D. T. 18% E. C. ..	At Sprouting	1 fl. oz. in 5 gallons	1·23
		1 fl. oz. in 2·5 gallons	1·23
	At Sprouting and at Tuber Formation ..	1 fl. oz. in 5 gallons	2·73
		1 fl. oz. in 2·5 gallons	2·36
Untreated Check ..	—	—	4·4

TABLE IV—Results of Dorylus ant control investigations carried out at Rahangala in 1958

Insecticide	Dilution	Frequency of treatment	Weight of Tubers harvested in lb.			Percentage of Dorylus Damaged Tubers
			Clean Tubers	Dorylus Damaged Tubers	Total	
Aldrin 20% E. C.* ..	1 fl. in 20 gallons ..	At sprouting ..	184½	4½	189	2·38
		+ at tuber formation ..	183½	4⅛	189⅝	2·20
	1 fl. in 5 gallons ..	At sprouting ..	186	3⅜	189⅜	1·78
		+ at tuber formation ..	172	1½	173½	0·86
Dieldrin 20% E. C. * ..	1 fl. in 20 gallons ..	At sprouting ..	185	12	197	6·09
		+ at tuber formation ..	142½	8¾	150¾	5·47
	1 fl. in 5 gallons ..	At sprouting ..	186½	9	195½	4·60
		+ at tuber formation ..	215	4¾	219¾	2·16
DDT 18% E. C. * ..	1 fl. in 5 gallons ..	At sprouting ..	154	13	167	7·78
		+ at tuber formation ..	158	12	170	7·06
	1 fl. in 2½ gallons ..	At sprouting ..	168	8	176	4·54
		+ at tuber formation ..	193	5⅝	198⅝	2·83
Untreated Check ..	..	— ..	123	63½	186½	33·87

* E. C. = Emulsifiable Concentrate.

TABLE V—Results of Dorylus ant control trial carried out at Bindunuwewa in 1958

Insecticide and Formulation	Dilution	Frequency of treatment	Weight of Tubers harvested in lb.			Percentage of Dorylus damaged Tubers
			Clean Tubers	Dorylus Damaged Tubers	Total	
Aldrin 20% E. C. * ..	1 fl. in 20 gallons ..	At sprouting ..	176	11	187	5·88
		+ at tuber formation ..	188	7	195	3·59
	1 fl. in 5 gallons ..	At sprouting ..	203	102	2132	4·92
		+ at tuber formation ..	191	5	196	2·55
Dieldrin 20% E. C. * ..	1 fl. in 20 gallons ..	At sprouting ..	157	12	169	7·10
		+ at tuber formation ..	201	11¼	212¼	5·31
	1 fl. in 5 gallons ..	At sprouting ..	177	8	185	4·32
		+ at tuber formation ..	176	5½	181½	3·03
DDT 18% E. C. * ..	1 fl. in 5 gallons ..	At sprouting ..	165	18	184	10·33
		+ at tuber formation ..	178	16½	194½	8·48
	1 fl. in 2½ gallons ..	At sprouting ..	167	12½	179½	6·96
		+ at tuber formation ..	161	8½	169½	4·87
Untreated check ..	— ..	— ..	169	41	210	19·52

* E. C. = Emulsifiable concentrate,

METEOROLOGICAL REPORT

Summary for April-June 1958

During April afternoon and evening thundershowers were well in evidence in Kurunegala District and south-western mid-country and among the Haputale Hills. The monthly rainfall there ranged generally between 10 and 20 inches, with a few stations reporting totals over 25 inches. Outside these areas the rainfall was less, while in the northern regions and in the eastern and south-eastern coastal areas the weather was mainly dry, with monthly rainfall of the order of two to three inches only. The rainfall over the Island was chiefly above normal, the greater excesses (of the order of 5 to 10 inches) occurring in the North-Western Province, among the Haputale Hills and in the neighbourhood of Labugama. Slight deficits occurred scattered over the Island.

Afternoon and evening thundershowers of April continued for a few days in May too, giving fairly widespread, but scattered rain, mainly in the western half of the Island. South-west monsoon conditions set in about the 9th of May, causing unsettled weather which was severe in Ragama-Nattandiya area and neighbourhood. This region experienced heavy rain both on the 9th and the 10th, aggregating rainfall amounts of the order of 10 inches for the 2 days. The resulting floods caused considerable damage to house, property and paddy crops in this region and great inconvenience to residents of Negombo Town. South-west monsoon weather continued thereafter, with light to moderate rain, mainly in the south-western low-country. Monsoon conditions weakened for a few days from the 20th, when evening thundershowers were experienced in the north-central parts, in addition to the monsoon rain in the south-west. Greater monthly totals of rainfall occurred in the south-western low and mid-country, where several stations recorded amounts exceeding 25 inches. From this region, the rainfall decreased gradually towards the north and the east, monthly totals outside the south-west quarter being mainly below 10 inches. Least rain occurred in the Northern, Eastern and North-Central Provinces, where the monthly totals were generally below 5 inches. The rainfall was well above normal along the west coast and among the Uva Hills, while it was well below normal in the south-western hill-country. Elsewhere over the Island, the rainfall did not deviate much from average.

Active monsoon weather prevailed during June. Winds over the Island were generally light to moderate south-westerly, with occasional

stronger squalls. Rainfall was mostly confined to the south-western parts, heavier amounts occurring in the south-western hill country and the adjacent mid-country. In these regions rainfall was a matter of daily occurrence, and the monthly totals exceeded 25 inches at several stations, the highest being 45.83 inches at Weweltalawa Estate (Yatiyantota). In the south-western coastal areas the monthly rainfall was of the order of 10 inches. Outside the south-west quarter the rainfall decreased rapidly, the monthly totals being mostly below 2 inches. About 120 stations, mainly in the north-central parts (Mannar-Trincomalee area), recorded no rain at all. The rainfall was below normal except in the south-western low and mid-country, the excesses in the latter region ranging generally from 2 to 5 inches. The bigger deficits occurred in the central parts of the hill-country, and also ranged from 2 to 5 inches. Outside the south-west quarter the deficits were slight (generally below 2 inches).

A. P. KANDASAMY,
Acting Director.

Department of Meteorology,
Bullers Road, Colombo 7, July 31, 1958.

METEOROLOGICAL REPORT

	APRIL								
	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	Number of days
Anuradhapura ..	92·8	+1·1	74·9	+0·5	76	95	5·39	—1·04	16
Badulla ..	84·8	+0·7	66·9	+0·7	74	95	9·04	+2·04	21
Batticaloa ..	89·3	+1·4	77·8	+1·1	77	91	1·65	—0·65	9
Colombo ..	88·7	+0·9	75·7	—0·1	75	93	7·88	—1·19	18
Diyatalawa ..	79·3	+1·3	61·1	+0·5	78	94	11·09	+4·55	21
Galle	87·5	+1·4	76·6	—0·1	74	86	10·58	+1·87	16
M' Illuppallama ..	91·7	+1·1	73·9	+0·2	75	98	10·58	+3·34	15
Hambantota ..	89·2	+1·6	76·9	+0·7	76	91	4·32	+0·46	11
Jaffna	90·9	+1·3	81·2	+1·0	69	83	1·70	—0·53	7
Kandy	88·1	+0·4	70·3	+0·3	76	95	10·85	+4·85	16
Kankesanturai ..	92·3	+0·8	79·1	+0·5	69	91	1·77	+0·23	5
Kurunegala ..	91·7	+0·7	74·4	—0·2	73	95	16·51	+6·60	19
Mannar.. ..	91·7	+1·4	78·6	+0·6	71	86	4·43	+1·01	11
Nuwara Eliya ..	72·9	+1·7	51·5	+1·5	77	88	7·01	+2·03	18
Puttalam ..	90·9	+1·6	75·6	—0·5	70	88	12·76	+7·88	20
Ratmalana ..	89·8	+1·9	75·4	—0·1	72	93	10·46	—0·11	17
Ratnapura ..	93·6	+2·4	74·1	+0·4	67	88	9·10	—4·47	21
Talawakele ..	76·5	—1·0	58·1	+0·3	76	89	7·80	+1·50	17
Trincomalee ..	90·8	+1·5	79·2	+1·5	72	87	3·56	+1·43	7

	MAY								
	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	Number of days
Anuradhapura ..	90·0	—0·9	76·3	—0·1	75	93	4·30	+0·76	11
Badulla ..	85·3	—0·3	67·2	+0·8	74	95	6·67	+1·98	15
Batticaloa ..	90·4	+0·1	78·0	+0·2	74	89	1·43	—0·36	8
Colombo ..	87·0	+0·1	77·8	+0·1	78	86	18·81	+3·32	27
Diyatalawa ..	79·1	+0·4	63·2	+1·2	76	89	11·31	+5·25	15
Galle	85·6	+0·6	78·5	+0·4	77	82	13·75	+1·08	22
M' Illuppallama ..	89·7	—0·7	75·6	—0·7	76	93	5·41	+1·23	23
Hambantota ..	87·9	+1·1	78·5	+0·9	80	89	4·48	+0·21	9
Jaffna	88·4	+0·2	81·6	—0·1	78	80	4·61	+2·61	7
Kandy	85·0	—1·0	70·7	+0·1	77	95	4·76	—1·75	13
Kankesanturai ..	90·2	—1·7	80·6	—0·9	76	89	4·58	+0·40	11
Kurunegala ..	88·9	—0·3	76·4	+0·3	74	91	12·14	+4·59	24
Mannar.. ..	89·4	—0·1	81·1	+0·3	76	83	2·65	+0·86	7
Nuwara Eliya ..	71·3	+0·9	56·3	+3·0	80	85	4·06	—4·41	22
Puttalam ..	89·0	+0·6	78·4	—0·5	75	86	8·57	+4·80	17
Ratmalana ..	88·1	+0·8	77·2	—0·7	78	91	22·27	+5·86	27
Ratnapura ..	89·7	+0·7	75·1	+0·2	74	88	14·88	—6·03	22
Talawakele ..	75·0	—0·7	60·5	+0·8	83	94	6·37	—2·04	24
Trincomalee ..	93·0	+0·8	79·5	+0·7	67	82	3·35	+0·12	4

	JUNE								
	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	Number of days
Anuradhapura ..	90·4	+0·4	76·9	+0·5	69	91	0·21	—0·52	7
Badulla ..	86·1	+0·7	66·7	+1·3	65	92	0·25	—1·29	4
Batticaloa ..	92·9	+0·6	78·6	+1·3	62	80	0·01	—0·88	1
Colombo ..	85·6	+0·3	78·0	+0·7	77	84	8·63	—0·03	25
Diyatalawa ..	78·2	+0·6	64·4	+1·2	66	79	0·71	—1·25	6
Galle	83·7	+0·2	77·5	+0·3	79	82	9·31	+0·87	27
M' Illuppallama ..	89·0	—1·5	75·8	—0·5	72	91	0·34	—0·99	4
Hambantota ..	86·3	—0·2	78·2	+1·1	79	89	0·45	—1·66	11
Jaffna	86·6	—0·1	81·3	+0·4	78	83	0·04	—0·35	1
Kandy	82·5	+0·4	71·0	+0·4	75	90	3·25	—4·05	23
Kankesanturai ..	90·8	—0·2	81·7	+1·1	70	83	0·19	—0·38	1
Kurunegala ..	86·9	+0·4	76·2	+0·6	78	91	4·92	—1·87	26
Mannar.. ..	88·9	+0·8	82·3	+1·7	73	79	0	—0·36	0
Nuwara Eliya ..	67·5	+1·9	57·6	+1·9	81	86	11·26	+0·83	24
Puttalam ..	88·0	+1·5	80·3	+1·1	72	80	1·62	+0·22	13
Ratmalana ..	86·5	+1·1	77·7	+0·3	81	91	8·94	—0·04	26
Ratnapura ..	87·0	+0·3	74·8	+0·1	74	86	22·33	+3·78	27
Talawakele ..	70·8	+0·1	62·3	+1·9	87	92	12·58	+0·30	26
Trincomalee .	94·2	+1·9	80·2	+1·1	58	78	0	—0·93	0